Cell Structure and Function

Introduction
•Cell (Structural and functional Unit+Building block)
•Theory of cellular Organization
- All compose of one or more cells
- Hereditary Material
- Metabolic Center
- New cell arise from previous cells

Techniques in cell Biology

Microscopy
•Necessary to understand cell
Resolution vs Magnification
•Resolution power of light microscope =250nm
•Resolution power of naked eye=500X
•Human naked eye can differentiate b/w two points at least 1.0 mm apart
•Magnification: means to increase the apparent size of object as much as 10,000 times.
•TEM can magnify 1,000,000 times.
•SEM has 3 dimensional image.

Staining
•To increase contrast of cell using stains.
•Non-toxic stain are called vital strains e.g Neutral red, Methylene blue
•Two strains can also be used, second is called counter strain.
•Strains can be temporary, Permanent.

Centrifugation
•Process of cell fractionation
•Homogenate the mixture by grinding
•Put in centrifuge and spin
•Inhibit at rapid speed and then increase
•Segregation according to density and size

Tissue culture
•Growth of tissue or cell separated from organism on gel (Agar & agarose)
Steps:
1. Select explant
2. Sterilization
3. Explant culture medium
4. Add nutrient
5. Callus formation
5. Shoot → Low auxin high Cytokinins
6. Root → High auxin low cytokinins
7. Potted up(Deflasked)

Chromatography
•Separation process
•Mixture move over stationary phase.
•Based on molecular mass and solubility
Paper chromatography
•Pigment separation
•Mixture placed in paper dipped in solvents
Column Chromatography
•Mobile phase flow over metal tube.

Electrophoresis
•Separate the charged particles.
•Influence of electric
•Speed of movement of particle depends upon charge and size of molecules.

Spectrophotometry
•Measure optical density.
•Mass directly proportional to optical density
•Used to do analysis of amino acid

Microdissection
•Use of microscope to aid dissection.
Chromosomes microdissection
•use fine glass needle
Laser microdissection
•use laser and microscope
Laser capture microscope
•use of laser and microscope to cause cell to adhere to film

Micrometry
•Measurment of microscopic objects
•Done by two scales
•One in eye piece (eye piece graticule) or ocular micrometer
•Second is on stage
Calibration should be done

Two stains may be used in which the second is called counter stain.

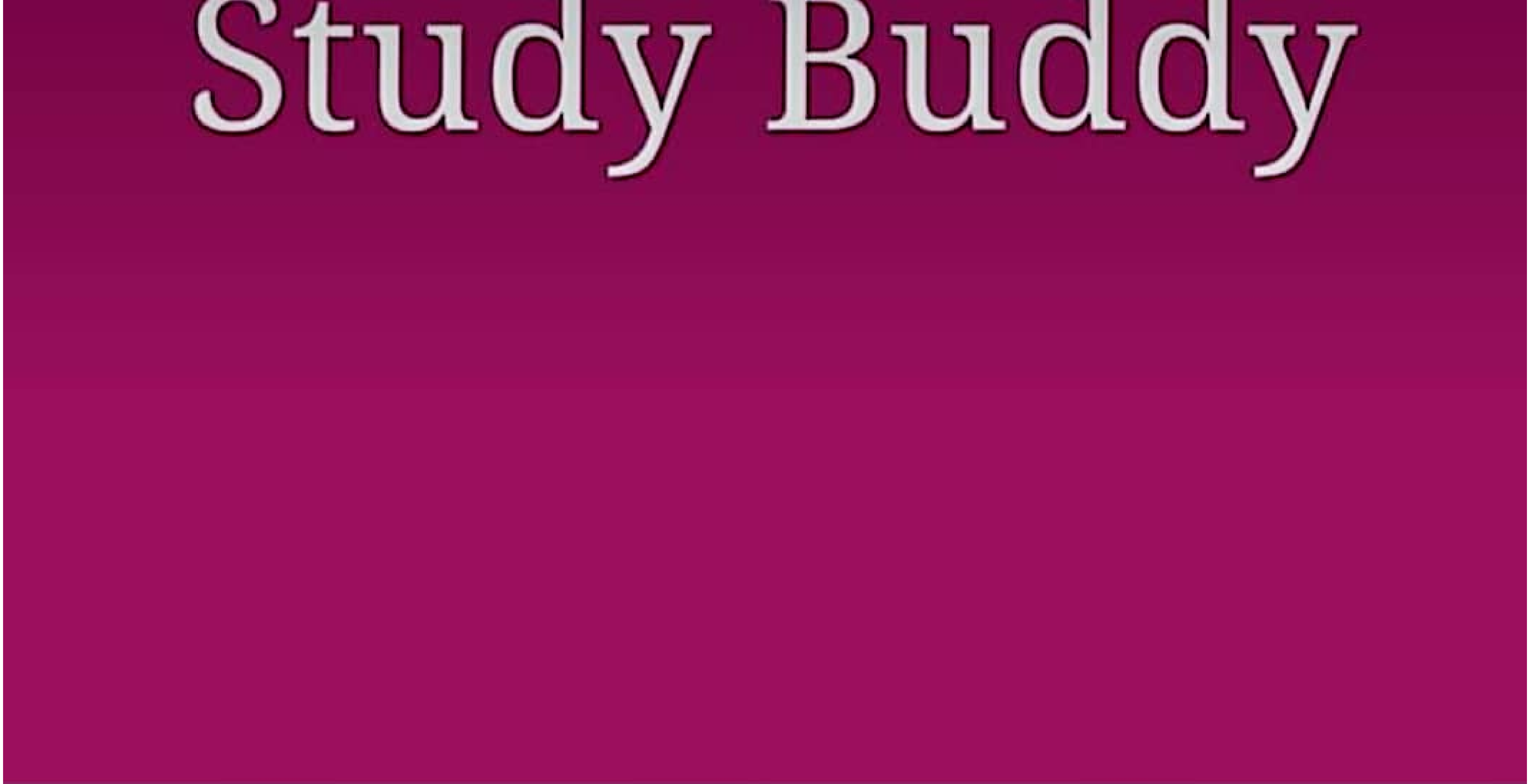
Permanent Stains

Stains	Final colour	Suitable for
i. Aniline blue	Blue	Fungal hyphae & Spores
ii. Borax carmine	Pink	Nuclei, Obelia colony
iii. Eosin	Pink / Red	Cytoplasm / Cellulose
iv. Feulgen's stain	Red / Purple	DNA (particularly during cell division) i.e. chromosomes
v. Leishman's stain	Red / Pink / Blue	Blood cells
vi. Methylene blue	Blue	Nuclei
vii. Safranin	Red / Purple	Nuclei, lignin & plant tissues

Temporary Stains

i. Aniline sulphate	Yellow	Lignin
ii. Iodine solution	Blue-black	Starch
iii. Schultz's solution (Chlor-zinc-iodine)	Yellow / Blue / Blue or Violet	Lignin, Cutin, Protein. / Starch / Cellulose

As revealed by the above table different cell organelles stain differently by different stains, hence increase the resolution power of a microscope.



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Cell

Other structures

Cell wall

•Discovery: R.Hooke,1665
•Secreted by protoplasm
•Adjacent cells are connected by M.Lamella (1μm)

<u>Middle Lamella (1μm):</u>
•Cement together wall of neighboring cells.
•Composition: Lignified

<u>Primary wall: (1-3μm)</u>
•Optically active, Elastic
•Composition: cellulose,Pectin hemicellulose
•Follwed by P.wall is S.wall.

<u>Secondary Wall:</u>
•5-10μm, less rigid, crystalline,
•strongly optical active
•Composition: Cellulose,Mineral salts(Ca^{++},Mg^{++},K^{+}), Non-cellulosic polysacchrides, Hemicellulose.

<u>Industrial use:</u>
•Rayan (Textile)
•Nitrocelulose (Explosive)
•Cellophane (Permeable membrane)
•Plastic

Plasma membrane

•Outer most boundary of cell
•20-40% lipids + 60-80% protein.
•Gorter & Grendel 1925;Two layers of lipid molecules only.
•J.F.Danieele & Davon 1935;Lipid bilayer is covered with protein &Protein pores.
•Robertson 1959;Unit membrane model.

<u>Fluid mosaic model:</u>
•Given by Sanger and Nicholson,1972.
•Sea of lipids, and proteins are floating.

<u>Protein and their role:</u>
•Intrinsic protein→Extend completely through the double layer of lipids from one side to other.
•Extrinsic Protein→Smaller, placed between phospholipids molecules.

<u>Role of Glycolipids and Glycoproteins:</u>
(Permeases)
•Functional diversity of membrane.
•Permeases regulate Diffusion, Osmosis, Active transport of ionic material.
•Harmone receptor sites(HRS), Nerve impulse receiving, Recognize antigen, Phagocytosis, Pinocytosis, Surface marker.

<u>Role:</u>
•7nm Wide, Transport, excretion, Ionic gradient, Maintain pH, Prevent escaping of cell content

Cytoplasm

•Part of living Content of cell
•90% water
•Soluble part (Cytosol)
•True & colloidal solution
•Sol(Non viscous)
•Gel (Viscous)
•Outer→Gel like
•Home of organelles
•Storage of chemical
•Cyclosis (Streaming movement)

Cytoplasmic organelles

Endoplasmic reticulum

•Network of channel between Nuclear and Cell membrane
•Separated by Cisternae

<u>SER:</u>
•Far from nucleus
•Lipid synthesis
•Detoxification
•Transport
•Communication

<u>RER:</u>
•Near to nucleus
•Protein synthesis

Ribosomes

•Plade (1955)
•20nm
•Discovered by Plade
•RNA+Protein
•At RER or in cytosol
•Large & small subunit
•Prokaryotes → 50S+30S=70S
•Eukaryotes→ 60•S+40S=80S
•Mg^{++} is required for attachment of subunit
•Polysome (Ribosome+mRNA)

•Free
e.g Haemoglobin

•RER
e.g Hydrolytic Enzymes

Golgi apparatus (Dictyosome)

•Discovered by Camillo Golgi (1898)
•Stacks of flat sacs called cisternae
•Unit is called Dictyosome
•Two faces
1.Proximal (cis) or forming close to nucleus
2. Distal (trans) or maturing located toward cell membrane.
•Vesicle from RER fuse with cis face.

<u>Function:</u>
•Storage of Secretory product
•Polysaccharide synthesis then combine with protein and lipids to form Glycoprotein & Glycolipids
•Add surface area to plasma membrane

Organelles

Lysosome
•Discovered By DeDuve (1949)
•Single membrane enzyme bodies (Hydrolyses & Acid Phosphatases)
•Engulf foreign particle
•Phagocytosis
•Enzyme formed on RER and budded off from Golgi as
•Primary lysosome

Function:
•Autophagy (Self eating)
•Degeneration of cell in development.

Storage disease:
•Accumulation of sunstances

Glycogenosis:
•Lipid accumulation in brain
•Mental retardation and death

Taysach:
•Glycogen accumulation in muscle and liver.

Peroxisome
• 0.5 μm
•Presence liver and kidney.
•Reduce effort of Hydrogen peroxide.
•In plants photorespiration.

Glyosxisome
• Catalase & glycolic acid oxidase
•Fatty acid→carbohydrate conversion
•Only in lipid rich plants

Cytoskeleton
•Discovered by Koltzoff
•Confirmed by Cohn (1977)
•Network of skeleton
•Main protein tubulin, actin, myosin, tropomyosin and other proteins of muscles.
•Derived orgnelles are cilia, flagella, basal bodies, centrioles.

Microtublues:
•long, unbranched, slender, tubluin protein

Functions:
•Assembly and disassembly spindle. Cillia+Flagella.

Microfilaments:
•More thin, actin protein, linked to inner face of plasma membrane.

Function:
•Cyclosis and amoebide movement.

Intermediate filament:
•Intermediate b/w Microtubules and microfilaments

Functions:
•Cell shape, Integration of cellular components

Centriole
•0.2 μm diameter (Near nucleus)
•0.3 to 0.5 μm long
•Hollow Paired cylinders
•Array of triplet of microtubules
•Form spindle (Microtubules organizing center MTOCs), Cilia, Falgella, Cytokinesis

Cilia and Flagella
•Both have same structure
•Cilia are more short & flagella are less and long
•Posses a central bundle of microtubules called axonemes in which nine outer doublet microtubule surround a central pair of singlet microtubules.
•Surrounded by plasma membrane

Mitochondria
•In all eukaryotes
•Power house of cell
•Discovered in mucles
•Self replicating
•Outer membrane→Smooth
•Inner membrane →Cristae, which enclose matrix.
•Own DNA and ribosomes
•F1 particles in cristae

Functions:
•Center of aerobic respiration
•Extract energy from ATP
•Energy Storage

Plastids
•Membrane bounded pigmented bodies

Chloroplast (4-6μm)
•Chlorophyll (absorb energy)
•Have Mg++ in center, Haem have Fe++.
•Stroma: Fluid surrounded thylakoid (DNA & Ribosome)
•Thylakoid: Disc like
•Granum: Pile of thylakoid (50-100) connected by intergranum.

Chromoplast:
•Other than green.
•Help in pollination, present in petals.

Leucoplast:
•Tubular, triangular, Colorless, Store food

Nucleus

Introduction
•Discovered by Robert Brown (1838)
•10μm diameter, slightly darker, spherical.
•Metabolic control & genetic (Chromosome)
•Mononucleate, binucleate, Multinucleate

Components

Nuclear Membrane
•Separate nucleus from cytoplasm
•Double membrane
1.Outer →RER
2.Inner →Enclose nucleus
•Have pores for exchange b/w cytoplsm & nucleus

Nucleolus
•Darkly stained without membrane
•Two Areas
1. Peripheral→Presence of ribosomes
2. Central fibril→RNA & rDNA

Nucleoplasm
•Colloidal mixture of organic & inorganic salts
•Chromatin is suspended
•Storage of enzyme, Raw material for DNA & RNA synthesis.

Chromosomes
•Thread like structure
•Chromosome
1. Centromere
2. Chromatids
3. Kinetochore
•Formed of DNA & protein Genes present at locus
•Diploid
•Haloid

DIFFERENCE	PROKARYOTE	EUKARYOTE
1) Cell Type	They are composed of prokaryotic cells.	They are composed of eukaryotic cells.
2) Nucleus	Nucleus is absent in them.	They have well defined nucleus.
3) DNA	DNA is without any nuclear membrane covering and is directly submerged in cytoplasm.	DNA or chromosomes is enclosed in double nuclear membrane.
4) Membrane-Bounded Structures	Membrane-bounded structures are absent. e.g. mitochondria, ER are absent.	Membrane-bounded structures are present.
5) Ribosomes	They have small sized 70S ribosomes (50S+30S)	They have large sized 80S ribosomes (60S+40S)
6) Cell Wall	Their cell wall is composed of polysaccharide chain covalently bonded with shorter chains of amino acids forming peptidoglycan or murein. Sacculus: a single huge molecule or molecular complex, often representing the entire prokaryotic cell wall.	Cell wall of plants is generally composed of cellulose.
7) Cell Division	They reproduce by binary fission.	They reproduce by mitosis and meiosis.
8) Histone Proteins	DNA is not associated with histone.	DNA & histone form nucleosome or chromatin.
8) Example	Bacteria and blue green algae	e.g. Multicellular animals, plants, fungi and protista.

Bacterial cell
•Murein
•Cell wall→Prevent from osmotic lysis
•Lack chromosome
•Small ribosomes (70S)
•Binary fission/Multiple fission
•Conjugation

Biological Molecules

Introduction
- World→Elements
- Elements→Atoms
- C,O,H →95% of all body weight
- Biochemistry: Deal with structure, Composition and function of molecules present in living organism.
- Carbon bonding with H,C,O form organic compounds.
- Organic molecules→Organelles
- Protoplasm

Organic
<u>Protein</u>
- Most abundant
- Structural and Functional role
- Enzymes, Hormones

<u>Carbohydrates</u>
<u>Lipids</u>
<u>Nucleic Acid</u>

Inorganic
<u>Water (3/4 of cell by weight)</u>
Salts

Fundamental Biological Molecules

Nucleic Acid
- DNA & RNA
- Synthesis of protein
- DNA→Inheritance
- Information to next Generation

Protein
- Most abundant
- Formed of A.A
- Structural and Functional role
- Enzymes

Lipids
- Diverse group
- Reserved food
- Building block

Carbohydrates
- Hydrated carbon
- Next to protein in abundance
- Building of plant cell
- C,H,O used in respiration Reserve food

Molecules

Organic
- Have functional diversity
- OH (Alcohol)
- Carbonyle group
- Aldehyde, Ketone Amino groups

Inorganic
- Water, Inorganic salts
- Water is vital for cell
- Without water no normal function is performed
- Salts→Small amount but important for cell

Processes

Condensation
- Large molecules are called polymers formed of small organic molecules Called monomer (Back bone of polymers)
- Two monomers join when "OH" is removed from one and "H" is removed from another.
- This is called condensation.

G+G=Maltose
G+F=Sucrose

Hydrolysis
- Breakdown of polymers by hydrolysis
- Reverse of condensation
- OH → one & H to another
- Hydro (Water) Lysis (Break)
- Sucrose + Water→G+F

Importance of water
- Backbone of life
- 70-90% of body
- Below 10% protoplasm can not survive
- Very Adaptable physical and chemical nature.

Polar Nature
- Polar
- Oxygen end (-ve)
- Hydrogen end (+ve)
- Bonded by Hydrogen bonding but strong enough to attach water molecule

Universal Solvent
- Polar→Dissolve all type of polar substances.
- Facilitate chemical reaction
- NaCl in water Na+, Cl-
- Dissolve mineral which absorb by plants and transported

Adhesive &Cohesive forces
- Water attach by H-bonding, this develop cohesive forces
- Water adhere to surface, fill a tubular vessels and still flow.

High specific heat and heat of vaporization.

<u>High specific heat:</u>
- Heat required to raise temperature of 1g water to 1 degree.
- Absorbing large heat without changing temperature help to protect rapid temperature changes.

<u>Heat of vaporization:</u>
- Heat required to convert 1g liquid water to vapours.
- Help to get rid of excess heat by sweating and transpiration.

Expand at low temperature
- Expand at 4 degree.
- Most heavy at 4 degree.
- Ice is less dense than water, so float on water.
- High surface tension allow thin water film to cover membrane.
- Without H bonding water biol at -80 Degree.

Ionization
- Ionize to H+ and OH-.
- Required for enzyme function

Biological Molecule

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Carbohydrates

- Polyhydroxy aldehyde or ketone
- Yield "OH" on hydrolysis.
- Abundant in nature
- Have (C,H,O)
- Ratio of C and H2O is 2:1
- Many have different ratios e.g; sucrose starch, maltose

Monosacchrides

Properties
- Simple, Non hydrolysable,
- Sweat, Water soluble,

Formula
- (CH2O), O & H ratio 1:2
- Have aldehyde and ketone group
- Have 3-7 Carbons.
- Glucose and fructose from ring structure in water
- Optical isomers, Sterioisomers

Oligosaccharide

Properties
- On hydrolysis produce 2-10 Monomers.
- Monomers are joined together by Glycosidic linkage.
- Common is disaccharides (Sucrose, Lactose)
- Sucrose+water→Glucose+Fructose
- Lactose+water→ Glucose+Galactose
- Maltose+water→Glucose+Glucose

Polysaccharide

- Polymers of mono-saccharides

Form more than 10 monomers on hydrolysis
Insoluble, tasteless

Starch
- Photosynthesis, Polymer made up of many glucose in branched, unbranched chain stored in plant cell.

Glycogen
- Stored in animal cell, formed of glucose in branched form.

Cellulose
- Unbranched chain of glucose.
- Building blocks of plant cell wall.
- Most abundant.
- Bonds are diff than starch and glycogen.
- Can not digest by human due to lack of cellulose e.g cotton

Chitin
- Exoskeleton of arthropods.
- Polymer of glucose and Nh2

Not digestable

Importance

Source of energy
- Bond break in respiration
- 100mg/100ml glucose in blood.

Building material
- Cellulose→Cell wall
- Chitin→Fungus wall +Exoskeleton

Storage molecule
- Reserve food
- Grapes→27% glucose
- Honey→G+F
- Starch+Glycogen→ Future energy use

Proteins

- Most abundant in cell

Role in cellular functions
Have "C.H,S,O,N"
Monomer is Amino acid
20 types of A.A are common

Amino acids

- Central Alpha carbon
- NH2, R & COOH groups
- R is variable either H or alkyl group
- A.A joint by peptide bond between NH2 & COOH group.
- Dehydration process
- Two peptide bonds (Dipeptide and vice versa)
- Hb→O2 carry, 4 peptide chains
- Insulin→ 2 chains
- Number and sequence is important (Sickle cell anemia)
- Glutamic acid→Valine

Shape

Fibrous
- One or more fibers (Fiber like)
- Insoluble, sheet like,
- Keratin (Nail, fur, skin)
- Collagen

Globular
- Spherical shape,
- Folding of peptide chain,
- Water soluble.
- Myosin
- Myoglobin
- Enzyme

Levels of Structure

Primary
- Number and sequence of A.A
- By Sanger in 1951.

Secondary
- Spirally coiled

Tertiary
- 3D shape

Quaternary
- Two/More chains
- Large size molecule

Functions

- Structural and building block (Lipoprotein)
- Enzymes (Digestion+Speed up reaction)
- Hormones(Insulin)
- Muscle (Actin+Myosin)
- Hameoglobin
- Bean, Pulses, Pea

Biological molecules

Lipids

Properties
- Heterogenous
- Composition: C,H,O,N,P
- Non-polar, Insoluble in water
- Soluble in ether,alcohol, more C-H bonds, less oxygen

Functions of lipids
- Energy Storage
- Plants(oils),Animals(Fats)
- More C-H bonds
- Building blocks of cell membrane
- Insulation
- Hormones (Auxin, Cytokinin, Gibberellins,aldosterone, testosterone)

Acylglycerol
- Composed of Glycerol+ fatty acid

Glycerol→3C compound, each have OH, OH is polar so water soluble portion of F.A react with OH of glycerol.
Fatty acid→Long chain, hydrocarbon have COOH (C16-C18)
Saturated (no double bond,plamitic acid, solid) or unsaturated (Double or triple bond, lipids also called oils e.g oleic acid.

Phospholipids
- One glycerol+2 F.A+H3PO4, Linked to N-base.
- Triglyceride→phospholipid when phosphate replace one fatty acid
- Hyrophilic head have OH
- Hyrophobic tail form double layer in plasma membrane

Waxes
- Long chain fatty acid bonded to alcohol
- Hydrophobic
- Solid at room temperature
- High Melting point
- Resistant to degradation.
- Water proof layer on plant leaves, fruits, animal,sheep, insects

Steriods
- Non fatty acid
- Backbone of 17C (4 rings)
- Differ in functional group
- Cholesterol precursor of Vitamin D
- Aldosterone (Regulate Na+)
- Sex hormones (Male, female charcters)

Terpenoids
- Non fatty acid
- Water insoluble,Isoprene unit
- Give rise to terpenes,Rubber on condensation
- Carotenoids (red, orange, yellow)
- Carotenes (Orange,red)
- Xanthophyll (Yellow)
- Widespread is beta carotene (Orange, carrot)
- Human body break to form Vit-A
- Beta-Carotene---2 Vit A molecules

Nucleic acid

Introduction
- Formed of Nucleotides
- DNA (Deoxyrobonucleotides)
- RNA (Robonucleotide)

Nucleotides

Mononucleotides
- Single nucleotide e.g; ATP
- ATP→Nucleotide + 3P
- Adenine + Sugar →Adenosine
- Adenosine+ P→AMP
- AMP +P→ADP
- ADP+P→ATP
- Energy currency of cell
- P-P bond is high energy bond, when break release 7Kcal energy
- ATP→Produced in respiration as food molecules break and energy release.
- ATP+H2O→ADP+P+7Kcal

Dinucleotides
- Two Nucleotides linked together.
- Adenine dinucleotide combination with vitamin form Co enzyme.
- NAD+,FAD, NADP+
- Oxidized and reduced form
- Oxidized form (H+ acceptor)
- NAD+ & FAD used in ETC and act as H+ carrier.
- NAD+---Niacin (B3)
- FAD— Robiflavin (B2)

Polynucleotides
- Many Nucleotides form a polynucleotide DNA and RNA

DNA
- F.Crick (1916-2004) J Watson(1928) M.Wilkin (1916-2004) presented model in 1962.
- Double helix, spiral stair case around central axis.
- Diameter→2nm, base pair distance 0.34nm.
- Pentose sugar, 4 types of Nucleotides (C,G,A,T)
- Base projected at side of strand
- Two strand opposite and form double helical structure.

RNA
- Polymer of Nucleotide

Ribose sugar
Four types of nucleotides (C,U,G,A)
Single helix,Uracil instead of thymine.

mRNA
Carry message to ribosome

tRNA
Transfer A.A from cytoplasm to ribosome

rRNA
Body of ribosome in combination with protein.

Biological molecules

DNA as Heredity Material

- Chromosome (DNA+Protein)
- DNA is responsible for transfer of information
- 1928→F.Griffith used mice & *S.Pneumoniae* (Pathogenic and nonpathogenic)
- Non-pathogenic bacteria absorb genetic material from pathogenic bacteria and change into pathogenic.

Avery, Mcloed, MacCarty

- Virulence of *Pneumococcus* due to DNA can be transfered to non-virulent bacteria.

Hershay & Chase

- Study life cycle of bacteriophage
- Phage have DNA in protein coat
- Phage inject DNA in bacteria and leave coat outside
- New virus made inside bacteria.

DNA→ Data Bank

- Have master plan of all characters of living organism, all data can be encoded using (A,G,C,T)
- All data e.g; skin color, size, inner organs, ears in DNA

Genetic code

- All information is encoded in DNA.
- Gene is unit of heredity.
- All organisms depends on gene.
- Information is transfered to next generation by DNA.
- A code is sequence of 3 Nucleotides (Nitogen base+Phosphate+Sugar)
- Code specifically amino acid to be bonded on polypeptide chain.
- 4 base (A,G,C,T) are involved which make 20 different amino acids.

RNA as carrier of genetic information

- Transfer of information takes place in two steps

Transcription:

- Transfer of genetic information from DNA to RNA

Translation:

- Transfer of genetic information from mRNA to A.A in a polypeptide chain.

Conjugated molecules

- Molecule formed by the combination of two different molecules belonging to different categories..

Lipoprotein

- Lipids+Proteins.
- Membranes of cells.

Nucleoprotein

- Nucleic acid+Proteins.
- Chromosomes

Glycolipids

- Sugar+Lipids.
- Brain & Plasma membrane

Glycoprotein

- Sugar+Protein
- Plasma membrane & Egg albumin

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Acellular Life

Introduction
- →Parasitism
- →Simple entities
- →Polio, small pox, hepatitis
- →Resistant to antibiotics
- →Vaccines
- →Plant diseases

Status of virus

Living Characters
(i) DNA | RNA
(ii) Reproduction
(iii) Mutation
(iv) Genetic recombinations
(v) Infection ability
(vi) Irritability

Non Living Characters
(i) Non-cellular structure
(ii) No respiration
(iii) No excretion
(iv) Crystallization

Discovery
- →Puzzling diseases
- →Tobacco mosaic disease
- →Iwanowsky demo
- →Foot & Mouth disease
- →Filterable diseases
- →Stately's work

Classification

Morphology based
- Spherical → Polio
- Tadpole Shaped → Bacterio-Phage
- Rod Seraped → TMV

Host based
- Animal → Polio, Small Pox
- Plant
- Bacterio **Phage**

Structure of representative viruses

Bacteriophage
→Obligate intracellular parasites

Size
→24-200nm

Head
→**Icosahedral**
→Filamentous
→Nucleic acid presence
→Head as protective cover

Tails
→Many have Tails
→Hollow tube
→Variable size
→Base plate + tail fibers
→Other structures

Lentiviruses
SIV: Simian Immunodeficiency Virus (Monkey)
FIV: Feline Immunodeficiency Virus (Cats)
VISNA: Visna Virus (Encephalitis +Chronic Pneumonitis in sheep)
CAEV: Caprine arthritis encephalitis Virus (Goat)

HIV
→No self reproduction

→Electron microscope
→Viral envelope

(i) 72 little spikes
(ii) Proteins gp120 & gp41
→Matrix
(i) Protein p17
→gp120+gp41→spike formation
→p17→Matrix formation
→p24→Core formation
→Core has 3 enzymes
(a) Reverse Transcriptase
(b) Integrate
(c) Protease

→Two RNA strands
→Retroviruses (lentiviruses)
→Complicated replication
→9 genes
→gag, pol, env (structural proteins)
→tat, rev, nef, vif, vpr, vpu
(Infection ability, new copies production)

Flu virus
→Variety of shapes(Round ball, Long Spaghetti)
→5 different proteins
→Enveloped virus
→8 pieces of RNA (viral genome)
→Segmented nature of RNA
→Hybrid programing
→2gps
- HA(Haemagluttin) →on lipid envelope
- NA(Neurominidase)→Infection Respiratory Tract

→HA→Pod shaped Triangular
→NA→Mushroom shaped spikes

Parasitic Nature of Viruses
Virus Envasion of immune Responses

(i) Avoid phagocytosis with help of Capsule, proteins and Fibrin etc
(ii) Cover by host proteins
(iii) Higher Mutation rate→Influenzas virus

Acellular Life

Virus & Host
- →No life Characteristics
- →Mostly host specific
- →Specific entry method
- →Entrance method & victam location
- →Different cell stages
- →Marking processes
- →Cell surface mollecules
- →Infection begins as attachment

Virus & Host
- →Bacteria eater
- →One Phage--One strain/Species

Lytic cycles
- →Master-slave relation
- (i) Attachment
- →Receptor site
- →Lysozyme
- (ii) Entrance
- →DNA Injution
- (iii) Control of biosynthetic Machinery
- (iv) Phage formation
- (v) Bacterial cell rupture
- (vi) Infection to new bacteria

Lysogenic cycle
- →Host-Guest relation
- →Integration into host DNA
- →Pass on to next generation
- →Lysogcnic→ lytic cycle

Cells of bacteriophage in Genetic Engineering
- →Useful vector (DNA carrier)
- →Destroy bacteria on multiplication

AIDS and HIV Infection
- →AIDS weakens Immune system
- →AIDS (Last stage)
- →Infection, weight loss, Cancer, Severe weight loss, Brain, CNS etc
- →Immune system → Structure, function
- →HIV very strong
- →Destroys T-cells
- →Infection spreads
- →Opportunistic Infection
- →Lymphocytes

B-cells (Antibodies)

T-cells (Directly Attack)

T-Helper
- →Antigen recognition
- →T-Killer Activation

T-Killer
- →Destroys Antigen

Life cycle of HIV

Binding|Fusion
- →Cd4 Protein
- →Cd4 and spile interaction
- →RNA release

Reverse Transcriptions
- →RNA $\xrightarrow{R.T}$ cDNA

Integration
- →Integration into host DNA
- →Intergrase
- →Provirus

Transcription & Translation
- →RNA formation (Nucleus)
- →Protein synthesis (cytoplasm)

Assemblys
- →RNA gathers with proteins
- →Viral particle completion

Budding & Naturation
- →Protease action
- →Mature viral coats
- →Infection to new cells
- →Passing on of HIV

HIV

Symptoms
→Appear b/w 6 weeks to 3 Months
→Early flu like symptoms (Fever, Rash, Muscular aches, Swollen Lymph nodes and glands)
→Mostly asymptomatic
→HIV Test
→Infection progress & Increasing iliacus
→No Treatment→AIDS (8 to 10 years of infection)
→Slowed down by medication
→ Life Expectation upto 15 years

Opportunistic Invasions
→Weak Immune system opportunistic infections

Symptoms
→Vision loss
→Pulmonary T.B
→Toxoplasmosis of Brain
→Severe bacterial infection
→Recurrent Pneumonia
→Nerve damage, Brain impairment

Signs
→Trouble thinking
→Loss of co-ordination and blance
→Behavioral Changes

Treatment
→No aire
→No Vaccine
→New Medication
- Slow progress of Infection
- Suppress HIV
- Restore Immune Function

→Antiretroviral Medication
→HAART or cocktail

Preventions
→HIV spread
→Sexual Contact
→Blood transfusion
→Pregnancy

Hepatitis: (Inflammation of liver)

Hepatitis A
→Most common form in children
→HAV
→Present in stool
→Mild form
→Un-noticed
→Short-lived illness (6moths)
→No chronic illness
→Incubation period (2-6 weeks)
→Non enveloped SSRNA

Hepatitis B
→Serum hepatitis
→Wide spectrum of symptomss
→Can cause liver cancer
→Spread by body fluids such as blood, saliva, urine, tear, Vaginal Fluid etc
→Incubation Period (4-20 Weeks)
→Enveloped dsDNA

Hepatitis C
→Symptoms similar to A & B
→Chronic liver disease
→Spread of HCV
(a)Shared needless
(b)Transfusion, transplant
(c)Mother to new born
(d)Sexual contact
→Incubation period(2-26 Weeks)
→Enveloped SSRNA

Diagnosis
→Blood Tests

Prevention
→Good hygiene
→Extra care while drinking/swimming
→Wash hands
→Antiseptic cleaners

Treatment
Hepatitis A
→No medication

Hepatitis B
→Medication

Hepatitis C
→Two Medication
→For children (1 drug)
→For adults (Combination of Drugs)
→50% elimination of virus

Viral Diseases

Herpes

→STD
→HSV-1(Oral+Genital), HSV-1(Genital)
→Genital Herpes → Blisters, → Pain
→Cold sore around mouth
→Sometimes No symptoms
→No cure
→Prevention is better
→Decrease discomfort + →Frequency limit → Medications

Symptoms
→Pain
→Tenderness,Itching
→Fever
→Headache
→Bumps and Blisters on Parts (Vagina, Penis, Scrotum, Thigh, Buttocks)
→Blisters----Sore that last 3 weeks
→Burning sensation during urination.
→Muscle aches.
→Tender.
→Swollen glands in groin region

Treatment
→Antiviral drug (ointment or pill)
→Shorten outbreak

Prevention
→Avoid unhealthy activates & sexual contest

Polio

→Affects young children
→Polio virus
→Spread by → Person to person, → Contact with phlegm, → Infected feaces

Entry via mouth and nose
Multiplication in throat and intestine
Absorption in blood and lymph system
Incubation time is 5 to 35 days (Average 7-14 days)

Signs | Symptoms
→Paralysis
→Attack Nerves
→Abortive polio
→Nerves in Muscles (limbs) + Muscles for breathing

Treatment
→Antibiotics for urinary Infection
→Bethanichol, urinary retention
→Moist heat
→Pain killer
→Physical therapy
→Braces | creative shoes
→Orthopaedic surgery

Prevention
→Vaccinations (Immunization 90% effective)

Leaf curl diseases of cotton

→Begomovirus
→Trnsmitted by by Bemisia tabaci

Symptoms

→Appears within 2-3 weeks (First symptoms)
→Downward cupping of young leaves
→Either upward | down ward curling of leaf margins swelling----darkening....formation of enations... cup-shaped, leaf like structure

Viral Diseases

Prions

→Infectious proteins
→Neurodegenerative diseases
→Coded ly host gene in Brain
→Misfolded protein in Bone Marrow cells and neurons

Scrapie

→In it CNS of sheep | goat affected

→Spread by
- Unhygienic way of feeding
- Infected Food

Human Prion diseases

- **CJD** **(Creutzfeld-jacob disease) Human form of Mad cow disease**
- **GSS** (Gerstmann-Strausslers-Scheinker Syndrom)
- **FFI** (Fatal Familial Insomnia)
- **Alpers syndrome**

Alpers syndrome

→loss of motor control
+
Dementia
+
Paralysis wasting
+
Death

Human Infected in 2 ways

(1) Acquired infection (Diet, Surgery, Growth Hormone injection, Corneal transplant)

(2) Apparent Hereditary Mendelian Transmission (Autosome dominant)

Virodis

→Simpler than viruses
→Small, circular, single stranded RNA molecules
→No protein coat

Plant diseases

- Potato spindle tuber
- Cucumber pale fruit
- Citrus Exocortis
- Cadang-cadang (coconut)

→Human disease by Viriods→Hepatitis D
→(PSTV) I→1st viroid (Potato Spindle tuber-Circular RNA)
→PSTV→Circular RNA

Prokaryote

Introduction
- Absence of True Nucleus
- Ability to exploit Harsh condition
- Seen with microscope
- Inverted in
  - (1) Nitrogen fixation
  - (2) Decomposition
  - (3) Photosynthesis

Taxonomy of Prokaryote
- In kingdom Monera
  - Archaea
  - Bacteria
- Domain Higher than kingdom
  - Also called super kingdom
- Divsion bases: Mode of Nutrition, motility, form, method of division.
- Domains of life (Dr. Carl Woese) 1970
  - Archea
  - Bacteria
  - Eukaryote
- Archea and Bacteria:
  - Prokaryote
  - Common Ancestor

Phylogeny of Prokaryote
- PCR is helpful to find phylogeny.
- 6300 species of prokaryote are assigned names.
- Prokaryote got genes from other species.

Archea

Arches
- Plasma membrane lipid bilayer (Different Lipid)
- Lack this complex
- Unique rRNA

Bacteria
- Lipid bilayer (Different lipid)
- Cell wall=Peptidoglycan
- Normal

Extreme condition (Extremophiles)

Extreme Halophiles
- Salt Envirnment
- Eg→Utah's Great salt Lake ant Dead sea
- Protein of cell wall help to survive

Extreme Thermophiles
- Heat environment
- Sulphur rich volconic springs (90°c)
- Some 121°c
- 150 feet below pacific ocean at Macdonald seamount

Moderate condition (Methanogens)
- Strict anaerobic envirnment
- CO_2+2H_2 CH_4+H_2O
- Marshes, Lake bottom, intestine
- Water thick Ice lake of Greenland

Bacteria

Classification

- Van Leeuwenhock 1618
- Louis Pasture + Robert Koch

Morphology
Mode of Nutrition
Biochemical+ Genetic characteristics

Proteobacteria

→Gram -ve bacteria Include
- Photoautotrophs,
- Chemoautotrophs,
- Heterotrophs.
- Aerobic→some
- Anaerobic→others

→alpha-Proteobacteria with eukaryote symbiosis
→Beta-Proteobacteria, Nitrogen recycling
→Gemma-Proteobacteria, Oxidizing H_2O→energy
→Delta-Proteobacteria
- Slime secreting→Myxobacteria
- May get attach to other bacteria

→Epsilon-Proteobacteria
Pathogenic to humans+ Animals

Chlamydias

- Gram-ve
- Pathogenic

↓ Humans

Spirochetes

- Free living
- Filamenteous
- Notorious parasite for Human.

Gram +ve bacteria

- Solitory+ Colonial
- Actinomycetes

T.B Leprosy
- Streptomycete+Streptomycin
- Mycoplasma

↓ Streptomyces
- Mycoplasma

Cyanobacteria

- Fed on oxygenic matter before.
- Cyanobacteria feed on Inorganic
- 2 billion year ago

↓ level of oxygen raise from 1% to 21%
- Nostoc→fixation of nitrogen

Structure of Bacteria

- **Capsule**
  - •Sticky, gelatinous
  - •Polysaccharide+Protein
  - •Prevent dehydration
  - •Less tight capsule= Glycocalyx
- **Cell wall**
  - •Peptidoglycan
  - •Han Cristian Gram
  - •1884
    - Gram +ve
      - •Blue-purple
      - •Thick wall
    - Gram -ve
      - •Pink
      - •Thin wall
      - •Lipopolysaccharide
- **Flagella**
  - •Anchored in cell wall
  - •Composition
    - Basal apparatus → Cytoplasmic Membrane + Cell wall
    - Curved Hook
    - Helical filament
    - (Curved Hook, Helical filament) → Flagellin
  - •Classification
    - Atrichous (No Flagella)
    - Monotrichous (One Flagellum)
    - Lophotrichous (Taft at one pole)
    - Amphitrichous (Tuft at both poles)
    - Peritrichous (On entire surface)
- **Pili**
  - •Small filamentous
  - •No part in motility
  - •Pillin protein
  - •Conjugation

Structure of Bacteria

- **Cell Membrane**
  - •Thin, delicate, Flexible, selectively permeable
  - •Just like eukaryotic mitochondrial membrane.
  - •Transport
  - •Energy role
  - •DNA replication (Mesosomes)+Division
  - •Mesosomes mostly in Gram -Ve
- **Cytoplasmic**
  - •Gelatinous mass of protein+Carbohydrates+ Lipids+Nucleic acid+Salts+Inorganic ions.
  - •Thick, semi-transparent,elastic,lacks membrane bound orgnelles.
  - •Cytosol.
- **Ribosomes**
  - •Protein synthesis
  - •70S

Bacteria

Genomic organization
- Less DNA than eukaryote.
- Single,Circular, Chromosome, few proteins
- Nucleoid = region
- Plasmid = contain genes

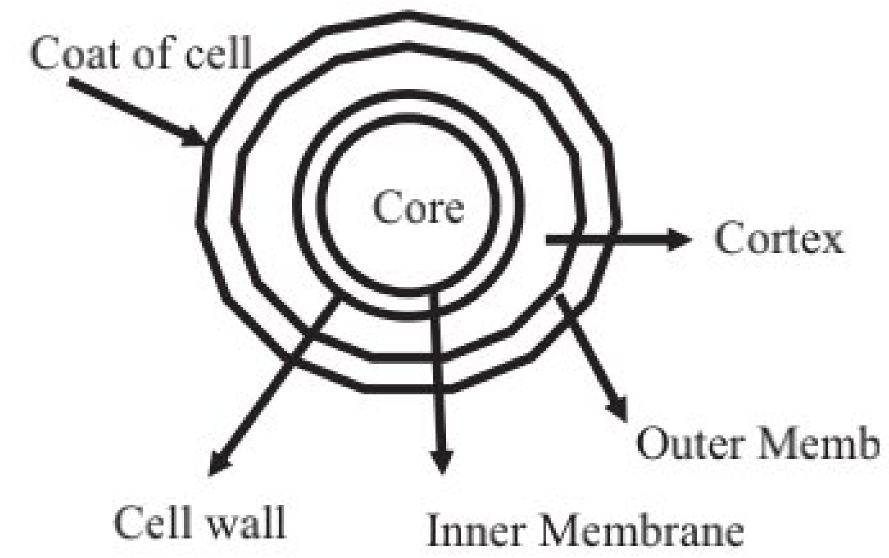
Size and shape of bacteria
- Most → 2-10u length; → 0.2 - 2u Diameter

Cocci (Coccus)
- Spherical
- Non-motile
- Lack flagella
- Diplococci
- Streptococci

Bacilli (Bacillus)
- Rod shape
- Diplobaccilli
- Streptobacilli e.g
  (1) Salmonella typhi
  (2) Clostridium tetani

Spirilla (Spirillum)
- Corkscrews-shape
- Motile
- Flagella at one end
- Never for colony or cluster
- Vibrio (comma shape)

Endospore
- Some Gram +ve
- Resistant to temp, radiation, water shortage
- Near end or center



- 7518 Year old .... Mummy have live spore

Mode of Nutrition in bacteria

Autotrophs

Photoautotrophs
- Posses Chlorophyll (Dispersed in cytoplasm)

$$CO_2+H_2S \xrightarrow[\text{Chlorophyll}]{\text{S.L}} C_6H_{12}O_6+S$$

e.g
- Purple Sulphur bacteria
- Sulphur bacteria
- Non-Sulphur bacteria

Chemoautotrophs
- Oxidation of Inorganic substance
- H_2S, NH_3.NO_3^1, NO_2^1 and Iron compounds.
- This process is chemisynthesis

Heterotraphs

Saprophytic
- Saprobes
- Decompose organic mataials by strong enzymes
- Utilize energy
- Recyclers of Nutrients
- Scavengers of earth

Parasitic
- Cause disease
- Pathogenic

Symbiotic

Mutualism
- Benificial for both

Commessalism

- Rhizobium radiciola → Roots of Legumious
- Nitrogen Fix
- Protection+food

Bacteria

Photosynthesis

	Bacteria		Cyanobacteria
(1)	O_2 No Release	(1)	O_2 release
(2)	H_2S(H_2Serce)	(2)	H_2O
(3)	PS-I	(3)	PS-I, PS-II
(4)	Only Cyclic electron flow	(4)	Cyclic + Noncyclic
(5)	Chlorophyll a	(5)	Chlorophyll a + Phycocyanin, Allophycocyanin Phyoerythrin

Growth in Bacteria

- Increase in total population.
- Growth affected by
  - (1) Temperature
  - (2) Availability of bacteria
  - (3) pH
  - (4) Ionic concentration
- 20 Mins ($1 \rightarrow 2$)
- Exponential growth
- Generation time (E.coli = 20 Mins)
- Phases of growth → 36 hours; Face of earth

Lag
- No growth

Log
- Fast growth
- Desire symptoms in Human appears

Stationery

Decline Phase
- Due to
  (1) Exhaution of nutrients
  (2) Toxic waste

Reproduction in bacteria

Asexual
- Binary fission
- Cell + membrane grows twice

↓

Accumulate nutrients

↓

Chromosome replicate

↓

Cell membrane grows Inward

Genetic variation → Mutation (•Major); Genetic recombination

Sexual
- Pitmitive
- Sexual reproduction, genetic recombination.

Transformation
- S-Type→Virulent
- R-Type→Non-virulent
- 1928→Frederick Griffith

Transduction
- Lederberg + Zinder 1952
- Bacteriophage
- Lytic phage cycle
- Temperate phage
- Lysogenic phage

Conjugation
- 1946 by Leder berg and Tatum (Biotin Experiment)
- E.Coli

Importance of Bacteria

In research Technology
- E.coli→Gene cloning
- Agrobacterim tumefaciens→ Producing transgenic plants

(Golden Rice contain beta-carrotene for blindness with vitamin A deficiency)
- Bioremediation→Remove pollutant from soil+air + water, radioactive
- Anaerobic bacteria→Decompose organic material in sewage
- Plastic Industy
- Natural degradealote plastic
- Vitamin→Bacteria
- Autibiotics
- Hormones (Insulin = Humulin)
- Disease resistant plants
- Ethanol→Fossil fuel

As Nutrient Recycler
- Saprophytic bacteria
- Scavengers of planet earth
- C, S, P, N cycles

Role in Ecology
- Nitrogen fixation
- Herbivores (cellulose)

↓

Commensalism

Other user
- Butter
- Cheese
- Yoghurt
- Antibiotic
- Vinegar
- A.A
- Protein
- Silage

Spoilage of food
- Decomposed by bacteria

Bacterial Disease

Humans
- Spread ways
  - Air born (Diphtheria + T.B + Pneumonia+Whooping cough)
  - Water born (Typhoid + Gasteroenteritis dysentery +Cholera)
  - Food born (Botulism + Food poisoning)
  - Wounds|cracks→Erysipelas
- Poisonous substance (Exotoxins+ Endotoxins)

Exotoxins	Endotoxin
(1) Protein	(1) Lipopolysaccharide
(2) Cytoplasm of living cell produce	(2) Gram -ve bacteria cell wall
(3) When bacteria living	(3) Release when bacteria die

Plants

Typhoid
- Rod-shaped Gram -ve bacteria
- Salmonella typhi

Transmission
- (•) By five F's
- (1) Flies
- (2) Food
- (3) Fingers
- (4) Feces
- (5) Fomites

Diagnosis
- Widal test

Symptoms
- Uler
- Blood in stool
- Little diarrhoea
- Mounting fever
- Lethargy
- Abdomen curved with red spots
- Gall bladder also affected

Treatment
- Chloramphenicol
- Vaccine

Cholera
- Vibrio cholera
- Gram -Ve curved bacteria.
- Enter in intestinal tract from food+water
- Dirarrhoea
- One liter colorless fluid lose/hour for several hours
- Eyes→gray, sink into orbit
- Wrinkle skin, dry, cold
- Muscular cramps in arms and legs
- Blood thick, Urine production ceases
- Patient in coma
- Mortality rate 70%

Treatment
- Tetracycline
- ORS

Preventions
- Sanitation
- Personal Hygiene
- Immunization give production 6 months

Bacteria Disease

Tuberclosis (T.B Skintest)

- Mycobacterium tuberculosis acid-resistant bacteria

Symptoms
- Chronic cough
- Chest pain
- High fever
- Expel sputum (rust color)
- Tubercle on lungs

Treatment
- Isoniazide
- Rifampin
- Ethambutal
- Streptomycin
- Vaccination = BCG

Pneumonia (Sputum Test)

- Disease of bacterial tube and lungs
- Streptococcus pneumoniae
- Capsulated Gram +ve bacteria
- Disease commonly called Pneumococcal pneumonia

Symptoms
- High fever
- Sharp chest pain
- Difficulty in breathing
- Rust color sputum
- Blood in lungs

Treatment
- Penicillin + Tetracyclin + Chloramphenicol

- Amount 80 strain cause pneumonia
- Vaccine for 23 strains only

Bacteria Disease

Bacterial leaf spots
- Caused by pseudomonas sp.
- Cucurbis beans + corn + many other plants
- Infected parts (leaves, stems, fruits, seeds)

Symptoms
- Spot on leaves
- Large Irregular Hole (Peppers + Cucurbits)

Favourable conditions for disease
- Worm temp
- Frequent rains
- High relative Humidity
- Use of diseased seeds
- Over crowding of plants
- Poor soil drainage

Prevention
- Crop relation
- Hot water seed treatment

Bacterial wilt
- Ralstonia solanacearum
- Potato + Tobacco + Brinjal+ Bannana+ Cotton+ Sweet potato

Symptoms
- Tomato+Brinjal (Wilting of terminal leaves) ,after 2-3 days whole plant wilt
- Potato----Quick wilt

Favorable conditions for Disease
- Leaving the infected crop residues in field
- Warm temp.
- High moisture content of soil
- High soil pH
- Infertile soil

Prevention
- Destroy infected plant
- Crop rotation
- Control of nematods
- Disinfected tools usage

Bacterial Soft rot

Erwinia Carotovora
- Potato + sweat Potato + Onion + Carrot + Tomato + Beans + Corn + Cotton + Crucifers

Symptoms
- Crucifers (Petiole Infetal)
- Carrot (Tap rot Infected)
- Corn (Dark brown)
- Potato (Tuber into cream to tan color soft tissue)

Prevention
- Preparation of properly drained soft
- Control of Nematods
- Removal of Infected Plant
- Crop rotation

Bacteria Disease

Bacterial galls

Crown galls by
- Agrobacterium tumefaciens
- Galls on roots + twigs + branches of plant of family Rosaceae.
- Mostly on ground level, on roots lower branches

Condition
- Warm

Spread
- Contaminated Soil
- Tools

Bacterial Blight

- Xanthomonas campestris
- Phaseoli
  Wheat, Barley, bean, oat

Symptoms
- Leaves (Light green spots)
- Spots yellow, lemon ring

Condition
- High moisture
- Humidity

Spread perenthon
- Crop rotation
- Oveineal imitation avoid
- Eliminations of crop reridre

Bacteria

Bacteria flora of Humans

Included bacteria + fungi

Benefits of Normal Bacterial flora

- Vitamin production
- Prevenmt chlorination of pathogens
- Kill Non-Indigeous bacteria
- Stimulate Natural Antibody production

	Body	Human flora
1.	**Oral cavity**	Streptococci and lactobacilli.
2.	**Respiratory tract**	**Streptococci, corynebacteria, streptococci, Neisseria sp., Gramnegative rod and cocci**
3.	**Urinogenital tract**	**Streptococci, corynebacteria and lactobacilli.**
4.	**Large intestine**	**Helicobacter sp., Bifidobacteria, Bacteroides sp., Lactic acid bacteria, Clostridia and Methanogens.**

Control of Bacteria

Physical Method

1-Heat
→Denature enzymes
→Moist heal effective
→100C°/10 Mins →kill vegetative form
→Sterlization
→High temperature short time Pasteurization (HTST)
→72C°→15/sec
→Uttres Hrgle temp (U.H.T) 140C°/3sec
→Dry heating→Loops+Needles
→Incineration→dry heat→ paper cups+dressings
↓
170C°/2 hours

2-Filtration
Vaccine, Enzyme, Antibiotics

3-Low temp treatment
0C°, 7C°

4-Desication
Water extracted

5-Osmotic pressure treatment
High salt or Sugar Cane.

6-Rootaction
- Ionizing radiation
- UV light
- Microwave radiation.

Chemical Method

- Phenol →Gram +ve bacteria
- Chlorine→Disinfect water
- Tincture Iodine→Antiseptic
- Alcohol
- Heavy metals (Copper + Selenium Mercury + Zinc) skin wound, pool, fish tanks, dandruff, shampoo, mouthwash.
- Formaldehyde→Preserve biologicals specimen
- Glutaraldehyde is effective than formalin
- Ethylene oxide kills→Microbes+ Endospore (4-18 hours exposure)

Protista and Fungi

Introduction
- Simplest eukaryote
- "Trash can" kingdom
- 60, 000 and 200, 000 potest

Protista
- Most unicellular and some multicellular or colonial
- Many have mitochondria (Endosymbiout)
- Many have chloroplast
- Polyphyletic origion

Animal like protists

Zooflagellate (Kinetoplastid)
→Termite→gut→feed
→wood→Trachonymph
→Trypanosomes
↓
→Trypanosomiasis

Amoeba
- Soft + shapless masses of cytoplasm
- Change in shape is by pseudopodia
  - Locomotion
  - Procurement
- Pseudopodia around the Prey and Digest
- Reproduce by Binary fission
- Abundant in fresh water + Soil
- Many cause dysentery
- Parasites

Foraminifera
- Heterotrophs + Marine
- Resemble tiny snails
- $CaCo_3$ shells / limestones
- Microscopic holes in shells through which Pseudopodia spoke
- Shell litter the sea flore
- Help to determine geographical age of strata.

(Apicoplast= F.A metabolism)

Alveolate
Aplicomplexans
- Spore forming parasite
- Called apicomplexans due to arrangement of fibrils+ microtubules+Vacuoles+Cell orgnelles at one end of cell.
- Plasmodium
- Female Anopheles carrier of plasmodium

↓ Bite
↓ Inject sporozoite (2n)
↓ Blood
↓ Liver (Merozoites-2n) → (Hypozoites) Dormant
↓ RBC (More Meozoites-n) → Tropozoiter (n)
RBC → Start showing symptoms of Malaria (Chill + fever + Nausea + Vomiting + Headache)
Male, Female (gametozoites)
↓ Mosquito (fertilization)
→ Gut → Zygote (2n oocyst) → Sporozoites (2n)

Ciliates (alveolate)
- Outer covering pellicle
- Two nuclei
  - Micro ↓ Sexual reproduction
  - 17000 ↓ Physiological function
- Paramecium food
  ↓
  Gullet(Vacuole)

- Paramecium
  └→Asexual (Transverse fission)
- Conjugation
- Blantidum coli
  └→Gut of pigs and rats

Plant like Protists

Euglenozoids

- Early organism to posses mitochondria
- 40 genera→Autotrophs
- Other→Hetrotrophs
- Some euglenoids become Heterotroptrs at dark
- Two flagella at reservior
- One flagella long protrude at reservior.
- Long flagella→propel body
- Body covered by protension Pellicle
- Contractile vacuole
- Photophagy

a + b + carotinodes

Dinoflagellates (Pyrrophyta)

Alveolata

- Unicellular

a + c chlorophyll carotinoides

- Cell walls generally missing but if yes the then cellulose
- Two flagella
- One encircle the cell
- Second perpendicular to it
- Red tides

Diatoms (Chrysophytes)

a + c + carotenes fucoxanthin

- Two Shells with silica
- Diatomaceous
- Asexual method common
- Sexual not common

Brown Algae (Phaephyta)

a + c + fucoxanthin

- Conspicous sea weeds
- Air bladder
- Alternation

Diploid Sporophyte
Halploid Gametophye

- Kelps (100m)
  - → Thalus
  - → Hold fast

Red Algae (Rhodophyta)

a + Carotens

- Phycoerythrin
- Corel reefs ($CaCO_3$)
- Agar
- Carrageenan

Green algae (Chlorophyta)

a + b Caster

- Unit Multicellular
- Store food as starch
- Ancestors of plants
- Chlamydomonas (Unicellular)
- Volox (Colony)
- Spirogyra (Multicellular)
- Zoospores = Asexual reproduce
- Sexual = Conjugation

Fungus like Protists

Plasmodial Slime molds

- Black balls in creamy-white, yellow-orange, purple or gray jelly like mass.
- Colorful→yellow, orange or red
- Plasmodium→Super cell→product of mitotic nuclear division not followed by cytokinesis
- Many diploid nuclei.
- Grow in water
- Meiosis occurs in flagellate gametes.
- Gamete→fuse→Plasmodium after mitosis

Oomycota (Water mold)

- All are parasite or saprophyte
- Zoospore→unequal flagella
  - Forward
  - backward

Oomycota	Fungi
Cell wall = Cellulose	Chitin

- White frozen body
- Phytophthora Infestans → late blight of potato
- Irish potato (400,000-1845-1847)
- Mycelium branches, unseptate hyalin + Intercellular
- Haustoria
- Sexual Reproduction oogamus
  - Male (Anthridium) + Female (oogonium)
  - → Oospore (2n)
  - ↓ Meiosis
  - Bearing←Sporangiophores (n) — Spongia
  - Produce←Zoospore (n)
  - ↳Asexual Haploid

Importance

(1) Foundation of food chain
(2) Oxygen produce
(3) Nutrient recycling
(4) 1/4 photosynthis→Algae
(5) Phytoplankton→Aquatic system
(6) Euglena→Sewage
(7) Trichonymph→Termites
↳Produce cellulose
(8) Disease
- Melaria
- Amoebicdysentary
- African sleeping sickness
- Giardiasis (Intestine Infection)

(8) Useful
- Carrageenan
  (1) Thickening agent in Ice cream
  (2) Pudding
  (3) Dairy produced
- Wax
- Plastic
- Lubricants

(9)Medicine→Ulcer
Hypertension
Arthritis
(10)Red Algae→
Vitamin+ Mineral

Fungi

Comparison with plants

Fungi	Plants
•No chlorophyll	•Chlorophyll
•Chitin	•Cellulose
•Not true Multicellular	•Multicellular
•Heterotrophic	•Autotrophic
•Saprophyte	•No
•Parasites of Plants + Animals	•No
•More closly related to Animals	

Largest organism Armillaria ostoyae

General Characteristics
- Heterotrophs
- Filaments (Hyphae) + Mushrum
- Chitin cell wall
- Nuclear Mitosis

Classification

Zygomycota
- Coenocytic
- Sexually by zygospore
- Some members Involved in rotting of bread, Peaches, strawb carrier, sweet potato.
- Parasitic symbionts
- Rhizopus Stolonifer (Life cycle)

Ascomycota
- Sexual spore = ascospores → In asci (Sac) → Ascocarps
- Asexual by conidiospores
- Powdery mildews
- More than 40% live as green algae + cyanobacteria
- Mycorrhizae
- Septate

Basidiomycota
- Mushroom
- Puffballs
- Shelf fungi
- Rust+Smut
- Club fungi mycellium

Primary → Manonucleate
Secondary → Dinucleate
Tertiary → Multinucleate → Basidiocarp

- Basidiospore
- Sexual uncommon

Importance of fungi

Pharmaceutical Industry
- Clavicep purpurea→Ergotamine →baby delivery + Migraine
- Penicillium Chrysogenum→Penicillin.
- Cephalosporium acremonium→ Cephalosporin (Antibiotics)
- Griseofulvin→Antifungal
- Cyclosporin→Immunosuppressant

Fungi food Industry
- Yeast
- Saccharomyces cerevisiae Baking + wine
- Frement→Carbohydrate

Research Projects
- Yeast
- 6000 genes
- Aspergillus→Citric Acid

Research Projects
- Morchella esculenta (Morel) / Tuber Melanosporum (Truffle) — Flavor
- Ectomycorrhizae→edible
- Yeast→50% protein + vitamin B

Importance of fungi

Symbiosis

Lichen
- Fungi+Algae
- Visible mostly fungi
- Fungi + (Cyanobacteria+ Green algae)or may be both.

Fungi → Algae
- Get protection
- Get Nutrients
- Natural dye

Mycorrhizae
- 80% plants has this association
- Increase surface area for water + soil

Fungi → Plant
- Get P, Zinc, copper
- Food

Types:
- Endomycorrhizae
- Ectomycorrhizoe

Recyclers
- Breakdown lignin

Food Spoilers
- Food decomposers

Pathogenic fungi

Plants diseases
- Cereals→rust(Puccinia)
  Smut→(Ustilago)
- 50% food get fungal attack
- Fruit diseases
  - Peach leaf curt
  - Pear leaf spot
  - Mildews
- Red rot of sugar cane
- Potato blight
- Late blight of tomato

Animal disease
- Ringworm in dogs and horses are caused by Trichophyton + Microsporum
- Abortion→Aspergillus sp.
- Parasite of carp and Salmon
  ↓
  Soporolegnia Parasitica

Human disease
- Rhizopus + Mucor→ Infection of Lungs + Brain + Gastric tissues
- Micosporum furfur
  ↓
  Dandruff
- Candida (Throat, Mouth+ pulmonary+Nasil, Genitals
- Neurospora+ Fusarium
  ↓
  Infection of corneal tissue of eye
- Aspergillosis (Just like T.B)
  ↓
  Aspergillus sp.
- Athletes foot

Diversity among plants

Evolutionary origin of plants

- 3 Billion years ago bacteria discovered by Barghoon and Achopt.

Phyletic Lineage

- Animals ⟶ 2 Million
- Plant ⟶ 0.5 Million
- Dicot species=2,00,000
- Monocots species=50,000
- Gymnosperms species=700
- Algae species= 18000
- Fungi species=80000

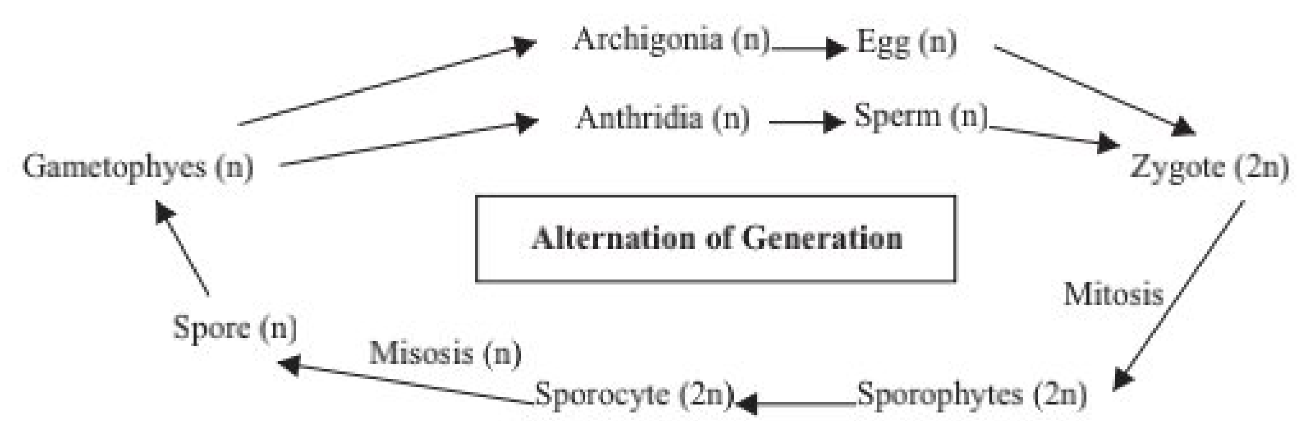
Diagnostic features of plants

- Higher plant ⟶ Independent sporophyte differentiated into roots, stem, leaves and
- vascular bundle.
- Possess chlorophyll
- Stationary
- Use inorganic elements
- Growth at tips, throughout life
- Show stimuli (External)
- Cell wall=Celluose

Evolution of Alternation of Generation

- Ulva+Ectocarpus(Algae)

Both generations independent
(Isomorphic alternation of generation)



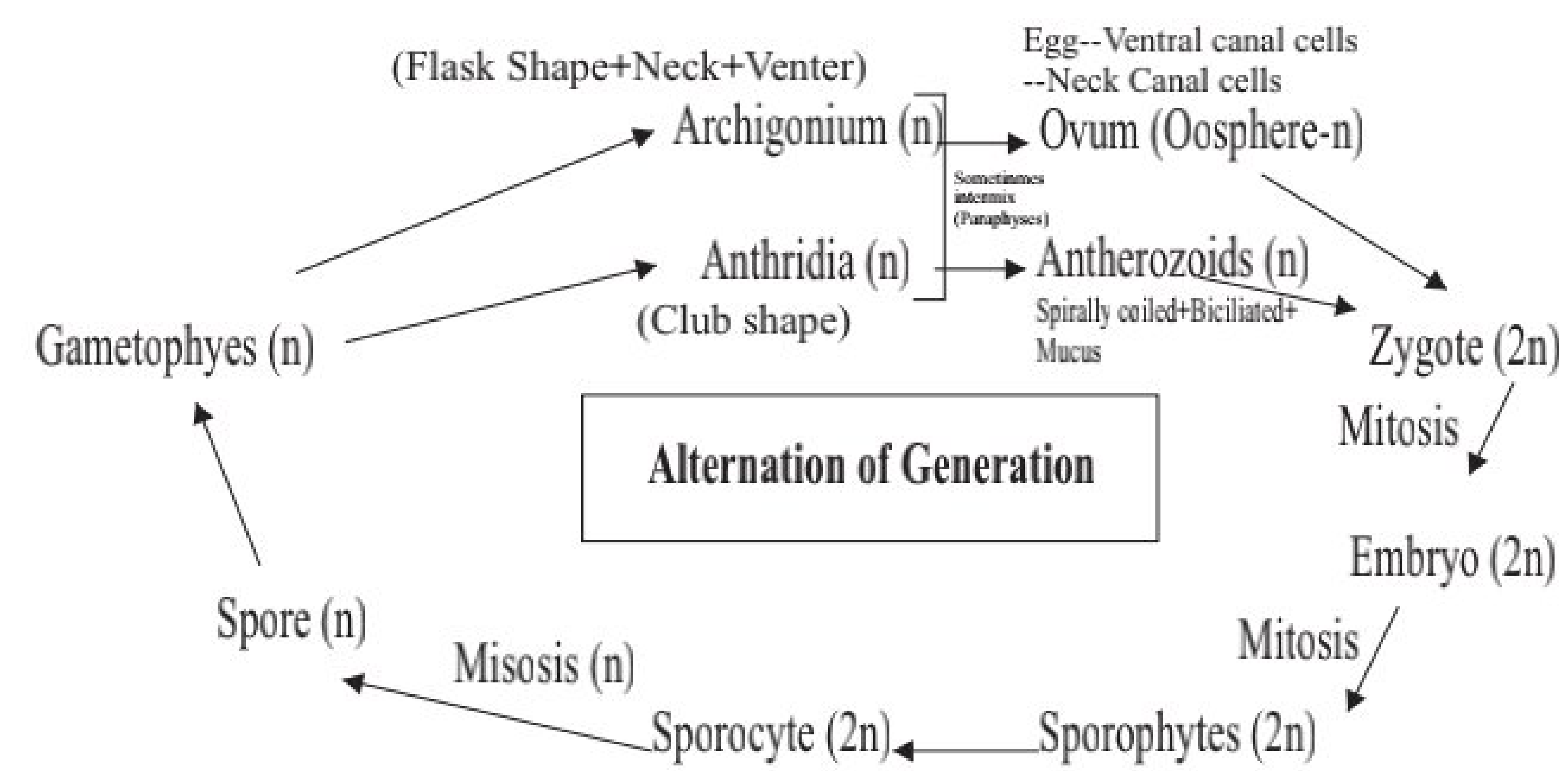
Bryophyes	Cryptogams
Vascular system absent	Vascular system present
Gametophyes Dominant	Sporophyte Dominant
Lower Plant	Higher Plants
Thallus body (Gam+Spo)	Root,Stem,Leaf,Gam=Thallus
Chlorophyll=Gametophtes	Chlorophyll=Sporophyte
Algae,Mosses,Liverworts	Lycopodium,Seleginella, Ferns,Gym,Angio

Life cycle of Moss

- Small 2.7 cm
- Rhizoids
- Axis branched
- Monoecious (Funaria)
- Dioecious (Polytrichum)

Land habitats

- Multicellular plant body
- Absorption of Co2
- Absorption of water
- Hetergamy
- Protection of reproductive cells.
- Embryo formation
- Alternation of generation



KINGDOM PLANTAE

Bryophyta (non-vascular Plants)

Classification

Hepaticopsida
- Liverworts
- 900 species
- Plant body; Gametophyte
- Plant body may be thaloid
- Attached to soil by rhizoids, (Marchentia)
- Upright falsy leaf(Porella)
- Special branches on gametoohyte
- Anthridiophore] Marchantia
- Archigoniophore] Marchantia
- **Examples:**
  Marchantia
  Porella

Bryopsida
- Musci,Mosses
- Archigonia
- Anthredia
  - Different Branch, Same plant, Funaria
  - Different Branch, Different Plant, Polytrichum
- Paraphyses
- Protonema
- **Examples:**
  Funaria
  Polytrichum

Anthocerotae
- Horn worts
- Anthridia+Archegonia partly sunken in Gametophyte
- Meristematic Tissues at junction
- **Examples:**
- Anthoceros

Tracheophyta (Vascular Plants)
- Root, stem and leaves
- Vascular system
- Protected sporangia
- Pollen tube
- Flower + tube
- Heteromorphic alternation of Generation.
- Spore Producing (Rhynia+ Psilotum,Club mosses, Horse tail+Ferns)
- Seed Producing(Gymnosperms+ Angiosperms)
- Herbs (Non-woody) +Shrubs(Branching near the ground --Woody) +Trees (woody)

Classification

Psilopsida(Psilophyta)
- Wisk Fern,Rootless, Leafless
- Rootless sporophyte
- Stem] Rhizome / Arial parts
- Earliest group of vascular plants
- Gametophyte thaloid
- Dichomous branching
- **Examples:**
  Extinct
  Rhynia
  Heterophyton
  Psilophyton
  Cooksonia
  Living
  Psilotum] Mycorhizae
  Tmesipteris] Mycorhizae

Evolution of leaf
- Leaf=Green,photosynthesis,transpiration, gaseous exchange,

Evolution of Microphyllous (Single vein)
- Club mosses and horse tail
- Two possibilities about origion

(1) Outgrowth— Need support(No vascular tissue)
(2) Reduction in size

Evolution of Megaphyllous (Many veins)
- Fork branching reduction hypothesis

Evolutionary Steps
⊗Overtopping
⊗ Planation
⊗Fussion/ Webbing

Selaginella (Life cycle)
- More than 300 species
- Slender stem⇒Furrows of leaves ⇓ Upper (Small) ⇓ Lower (Large)
- Rhizophore ⇒ Root like
- Two kinds of sporophylls (may be same cone or different cone, Microsporophyll, Megasporophyll)
- Sporophyll (Equal size, Spirally arranged, Usually in four rows,round the apex of reproductive shoots, four angles cone, Spongiferous spike or strobilus)

Lycopsida
- Club mosses

Living genera=Lycopodium+ Slegenella+Isoetes+Phylloglosum
Fossils=Lepidodendron+Sigillaria
- Sporophye+Roots+Stem+True leaves
- Microphyllus leaf

Characteristics
- Branching=Dichotomous
- Gametophyes=Large, underground, Independent.
- Legule to retain moisture
- Arrangement of leaf=Spiral
- Club shape Stobilli
- Homo/Heterospory

Examples:
- Lycopodium (One kind Sporagia- Legule absent)
- Selegenella (Two Kind Sporangia, Heteromorphy Leaves resembel with mosses)

Sphenospsida
- Horsetail
- Arthrophytes (Joints)
- Few feet height
- Root, stem, leaf
- Adventitous roots
- Spornagiophore... Sporangia
- Prothellus (Rhizoids) --- Gametophyes
- Distinct alternation of generation
- Sporangiophore arranged to form Stobili

Example
- Equisetum=Living
- Calamites=Extict

Pteropsida (Fern, Seed Plants)

Classes

Filicineae (Fern)
- Foliar
- sporangia attached to frond.
- Frond(Leaves)
- circinate vernation
- some are epiphytic
- **Examples**
  Dryopteris, Pteridium, Adiantum, Pteris

Life cycle of Adiantum
- Vegetative structure
- Small herb
- Strip black
- Rachis
- Stem=Short,Thick,Rhizome, lying horizontal, covered by persistent leaf basis.
- Roots=Fibrous+Adventitious+Arise from lower surface of rhizome.
- Leaf=Leaflets or Pinnae---Divided into pinnules. strip (Stalk)--Continue to rachis

Vegetative parts
- sorus green but when
- ripe become dark brown
- sporophyll (leaf bearing sporangia)
- Edge of capsule:] annulus 3/4. / stamium. 1/4.
- Spores] Haploid gametophyte. or Prothalus. (8mm) (Monoecious) Small,Heartshape, Photosynthesis.

- Sporangium=Flat+Biconves+Capsule
- Spore=Cytoplasm+Nucleus+Two layer cell wall (Innner=Intine,endosporium, outer=Exosporium)
- Spore develop to prothellus (Gametophyte) Contain chloroplast, Green,Small, flat,Heart shape, Bear rhizoids)
- Antheridia--Spermatocyte--Male gamete
- Archigonia--Egg (oosphere)
- Oospore (Zygote) Sporophyte (2n)

Evolution of seed

Class Gymnospermae

Class Angiospermae

Pteropsida (Fern, Seed Plants)

Evolution of seed

- Occur 390M year ago
- First complete seed 365 M years.
- Ripened fertilized ovule
  - Development of Heterospory.
  - Retention of megaspore inside the sporangium
  - Formation of integument around the megasporagium and evolution of ovule
  - Evolution of pollen tube

Class Gymnospermae

- 1/3 of forest
- seed plant
- produce seed but not fruit
- Naked seeded
- Important genera
- Cycad (sago-palm-**Rarely branched-C.Circinalis-Tropical**), Pinus(pine-**Temperate**), Taxus(yew) Picea (Hemlock), Cedrus (deodar), Ginko,Pine,Fir,Cedars, Spruce

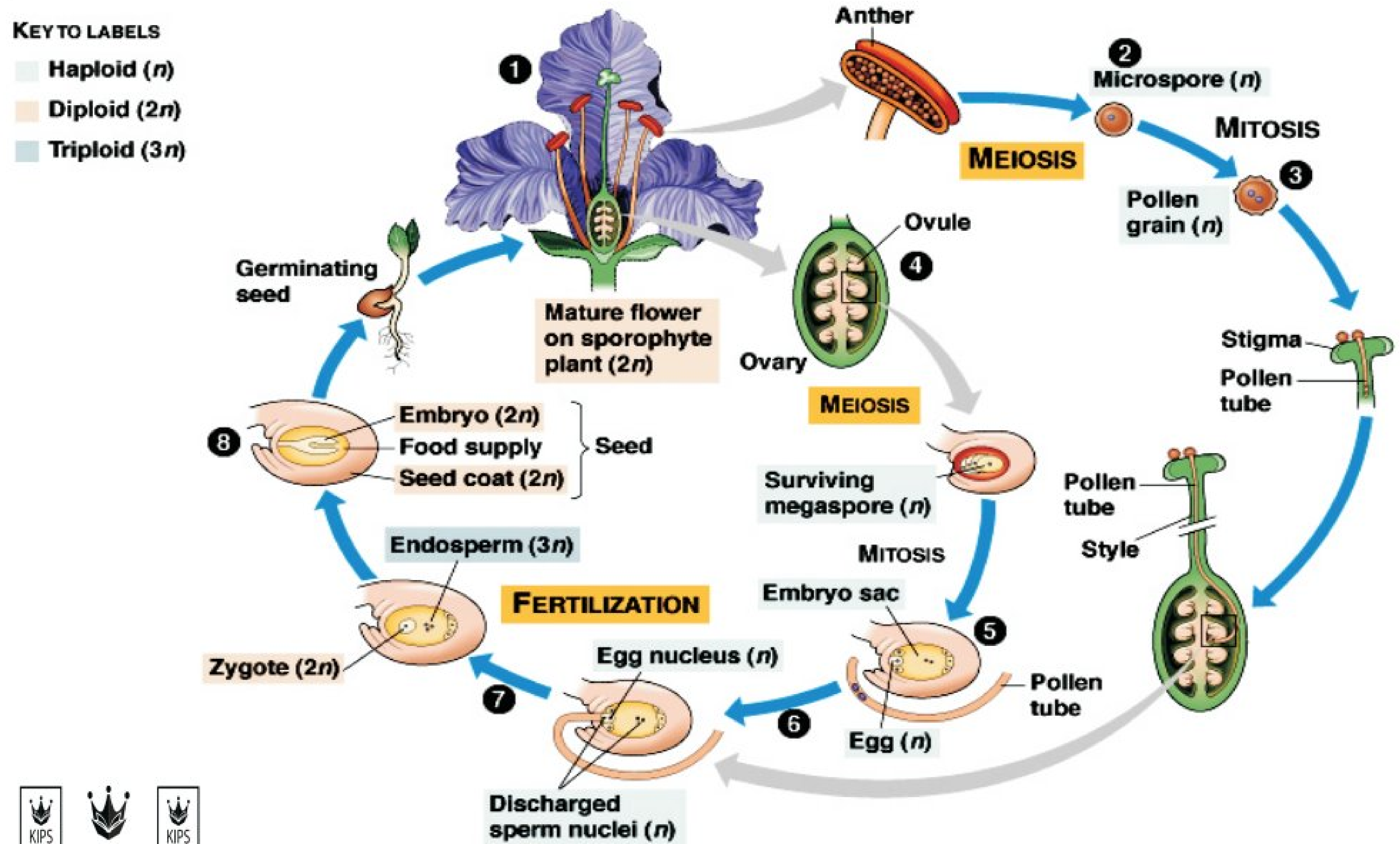
Pinus

- Coniferous Heterosporous
- Mircrospore --> Male --> small cone
- Megaspore --> Female --> Large cone
- Male + Female cone --> some plant
- Fertilization does not require water
- Male gametophyte = Mircrogametophyte
- Female gametophyte = Megagametophyte
- Pinus = Domiant diploid sporophyte
- generation alternates with Inconspicuous haploid gametophyte generation.

Class Angiospermae

- closed seeded
- 235000 / 360000 Known species
- **Life cycle**
  - Function of sepal + petal
  - Formation of Male Gametophyte
  - Carpel
  - Formation of Male sporophyte
  - Fertilization
  - Seed formation
  - Double fertilization

Dicot	Monocot
Emryo sac bear two cotyledon	One cotyledon
Plumule terminal and two cotyledon lateral	Plumule lateral, ctyledon terminal
Tap root	Adventitious roots
Reticulate venation	Parallel Venetion
Pentamerous	Trimerous
Vascular bundle in ring form	Vascular bundle scattered
Xylem bundle 2-6	Xylem bundle 5-8
Root cambium→secondary meristem→Secondary growth	Root Cambium→Absent→No growth



INFLORESCENCE AND ITS MAJOR TYPES

Racemose
- Main axis grow
- Last flower at axis
- Oldest at base

Typical Raceme
- Main axis is elongated
- Bears laterally a number of flowers.
- ***Cassia fistula*** (amaltas)

The spike
- Main axis is elongated
- Flowers sessile
- ***Achyranthus*** (puthkanda)
- Bottle brush.

Catkin
- Usually bears only pistillate or staminate flowers.
- ***mulberry*** and **willow**.

Corymb
- Main axis is comparatively short
- Stalks of the lower flowers longer than those of the upper younger ones.
- ***Iberis*** (candytuft)..

Umbel
- Main axis is shortened.
- Flowers stalked.
- Flowers at one level e.g. Hydrocotyl (***brahmibooti***).
- Carrot..

Penicle
- Branched raceme
- **Grapes, mango** and **oat**..

Capitulum
- Flowers sessile, crowed, short axis.
- Sunflower.

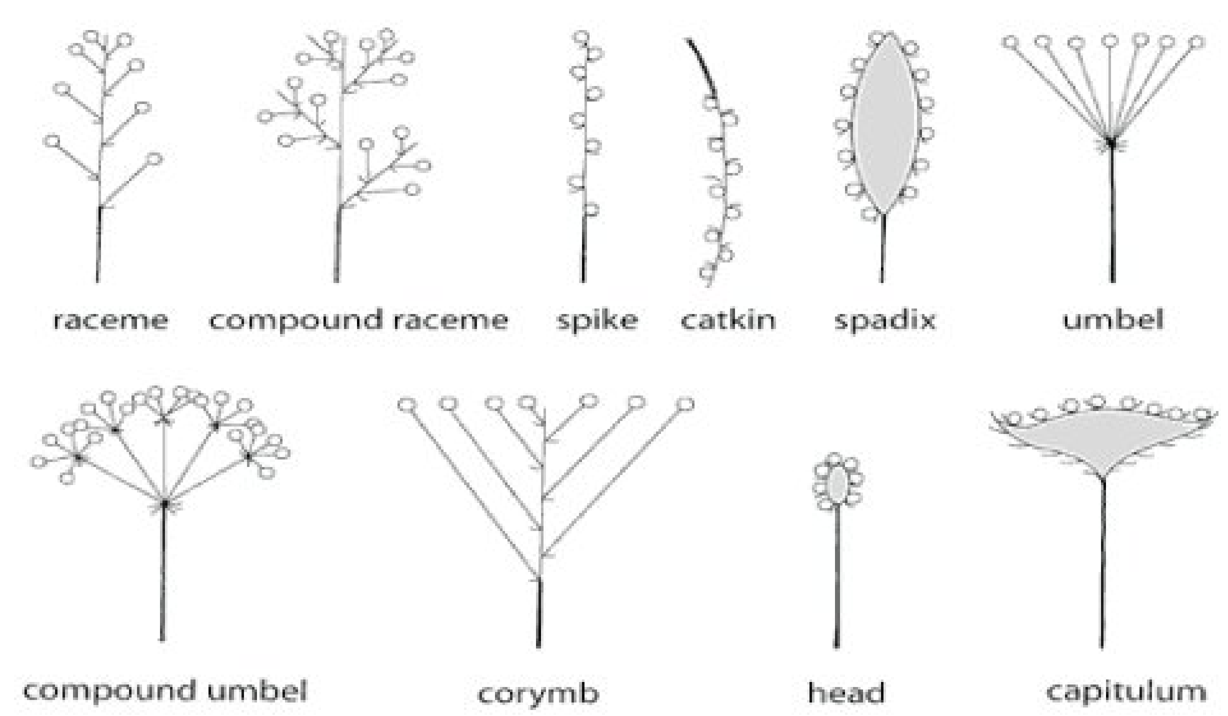
Cymose
- Main axis soon bear flower
- Terminal flower oldest
- Lateral Younger

Uniparous cyme
- ***Begonia, Tradescantia***.

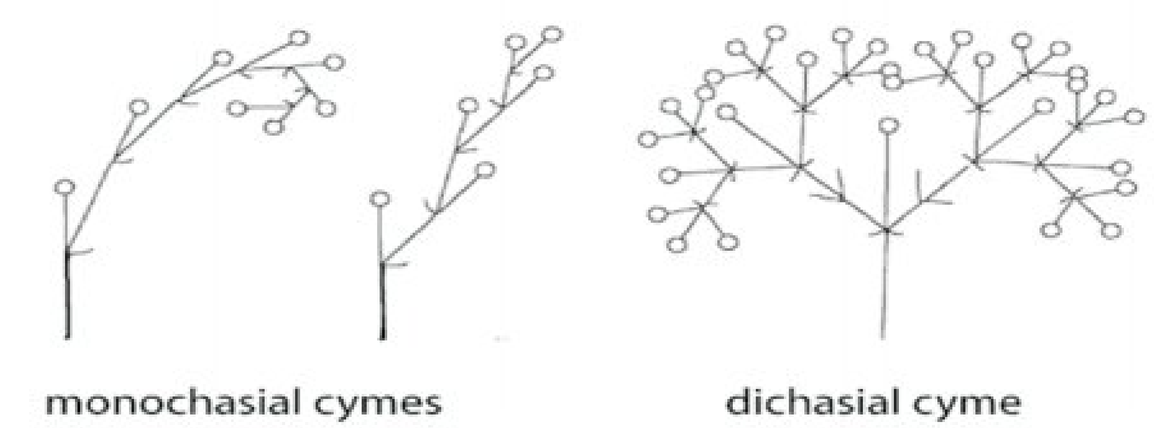
Biparous
- ***Silene, Ipomoea***.

Multiparous
- ***Euphorbia***..

racemose



cymose



PLANTAE

Benefits of Angiosperms for Humans

•Cereals:Corn, wheat barley, rye, rice;
Legumes: Beans, peanuts, soybeans;
Fruits, vegetables and nut.
Fibres: Cotton, limen (flax), jute, Indian hemp,
Manila hemp, Sisal hemp, etc., Rope, string nets and bags.
•Cotton fibres, used in the manufacture of clothing.
•Industries, medicines.
•Articles of daily use.
•Wood for building and furniture, fats, and oils, fibers,
cereals, fruits, sugar, drugs, (e.g. quinine, digitalis,
ephedrine, morphine, cocaine, etc.),
dyes (indigo, haematoxylon, saffron, chlorophyll, etc.),
tea, coffee, spices, tobacco, paper, tannins, resins, gums,
essential oils, rubber, fuel, alcohol etc.

Cannabis (*Cannabis sativa*)
Medicinally, sleeping disorders, autoimmune diseases and glaucoma.

Coca (*Erythroxylon Coca*)
Local anesthetic in the 19th century
Coca leaf tea is taken for altitude sickness in south America.

Daffodil (*Narclssusspp*)
Galantaminehydrobromide, used to treat Alzheimer's disease.

Deadly nightshade (*Atropa belladonna*)
Toxic chemical atropine, relax the muscles of the eye
Stop muscular spasms.

English yew (*Taxusbaccata*)
Taxols, treatment of breast cancer.

Fever tree (*Cinchona Succiruba*)
A native of Latin America,
Quinine, which is used to treat malaria.

Vascular plants as successful land plants

Adaptable to all kind of envirnments
Production of flowers, Fruits, Seeds

KINGDOM ANIMALIA

(Tissue)

Prazoa

Porifera

General Characters
- No tissue organization.
- Outer layer pinacoderm. (Pinacocyte)
- Inner layer choanoderm (choanacytes: food ingested)
- Between is mesenchyme.
- Few mm to more than 1 meter.
- Spongocoel.
- Water enter the body through ostia.
- Water leaves the body through = osculum.
- No respiratory /No circulodory system.
- Sessile
- Adult sponge sessile / larvae move
- No definite nervous system.
- Spicules = Skeleton.
- Asexual = Budding.] Internal (gemmules) / External
- Sexual > Hermaphrodite (protandrous)
- **Examples**
  Sycon, Leucoselania, Euplectella, Spogilla

Eumetazoa

Symmetry

Radiata (Diploblastic)

Coelentrata (Cnidaria)

General characters
- Cnidocytes
- Gastrovascular cavity/enteron.
- Polyps => gastrozoids
- Medusae=> free swimming (sexual)
- Nervous system=> Network of neurons
- No CNS
- Sessile
- Alternation of generation
- Plymorphism
- **Examples**
  Hydra
  Obelia
  Aurelia (jelly fish)
  Actinia (sea anemore)
  Medrepora (corals)
  Brachioceranthus.

Bilateral (Triptoblastic) Coelom

Acoelomate

Platyhelminthes

General characters
- Parasitic mode of life.
- Few mm(10mm) => several meters
- Sac like digestive system.
  Flame cells.
- Well developed Nervous system.
- Respiratory /circulatory system absent.
- Reproduction] sexual (Hermaphrodites) / Asexual
- **Examples**
  Dugesia (Planania-Tibellaria
  Regeneration only-10mm)
  Fasciola hepatica (liver flake)
  Taenia saginata (Tape worm)
  Cestoda(Digestive sys absent)
  Infestan / Disinfestans

Pseudocoelomate

Aschelminthes (Nematoda)

Aschelminthes Classes
1. Class Gastrotricha
2. Class Rotifera
3. Class Kinorhyncha (Spiny, marine, microscopic)
4. Class Nematoda
5. Class Nematomorpha (Resemble nematoda)

General Characters
- Pointed ends
- Female 8-16 inches, male 6-12 inches
- Tube like digestive system
- Parasitic mode of life
- Excretory system present
- Nerve ring
- Sense papillae
- Circulatory / Respiratory system absent
- Sexual Reproduction.
- Longitudinal muscles only
  27 million eggs one time+200000 egs/day

Examples
Ascaris lumbricoides
Enterobius vermicularis(Pinworm)
Ancylostoma duodenale

Coelomate

Proterostomes (Mouth from Blastopore)

Annelida (Trochophore Larvae)

General characters
- Metamerically segmented
- Prostomium = Digestion
- Excretion = Nephridia
- CNS = well developed
- Close circulatory system
- Respiratory system absent
- Muscle produced
- Organ of locomotion (setae)
- Sexual

Classes

Polychaeta
- Head with eyes
- (Palps and eyes)
- Sex = separate
- Locomotion Parapodia
- **Examples**
  Nereis
  Chaetopterus

Oligochaeta
- Locomotion Setae
- Head not promirat
- Hermaphrodite
- **Example**
  Lumbricus terrestris
  Pheretima posthuma
  Earthworm

Hirudinea
- Body=fixed number of Segments
- Annuls
- No organ of Locomotion
- Hermaphrodite
- No distinct head
- Anticoagulent Secretion
  Example
  Hirudo medicinalis

Gut, Blood vessels, Nerve cord=Cont.
4-5 Pairs of heart
Haemoglobin

Arthropoda

General characters
- More species than others
- Segmented body
- Appendages
- cuticle
- Heomocoel
- Tube like digestive system
- Excretory system=malpigian tube
- Highly developed Nervous system
- Trachea+Gills
- Colorless Blood
- Exoskeleton
- Separate sexes
- Metamorphosis

Classes

Crustacea
- Two pair of antenna at head
- One pair of Mendible
- 2 pair of Maxilla
- Separate sexes
- **Example**
  Daphnia
  Cyclops
  Crabs
  Lobsters
  Prawn
  Wood louse

Insect
- 1pair of antena
- Compond eye
- Separate sexes
- **Example**
  Drogonfly
  Mosquito
  Butterfly
  Moth
  Wasp
  Bettles

Archnida
- 2 pair of pedipalps
- 4 pair of legs
- No antenna
- No true jaws
- Book lungs
- Separate sexes
- **Example**
  Scorpion
  Spiders
  Mites
  Ticks

Myriapoda
- 1 pair of legs /segment
- 1 pair] antena / eyes
- **Examples**
  Centipeds (Carnivora)
  Millipeds (Herbivores)

Metamorphosis
Ecdysis or moulting
Stages inbetween sheding--Stadia
Form instar at any stage
Adult=Imago=Final instar

Ametabola	Hemimetabola	Holometabola
No metamorphosis Collembolan Wingless insects	Incomplete metamorphosis Cockrock Wasp	Complete Flies, Moths, Bettles, Butterfly

Mollusca

General Characters
- Second largest group of Invetebrate
- Mantle
- Radula
  System present:
  Digestive (Tube like)
  Respiratory (Haemocoele) => gills.
  Circulatory (open)
  Excretory (nephridia)
  Nervous=> 3 pair of ganglia → Head / Food / Body
  Reproduction
- Muscular feet
- Separate sexes

Classes = 6

Gastropodes
- Body covered one piece shall
- Asymmetrical
- Example
  Helix aspersa (garden soil)
  Limax maximum(the slug)

Bivalvia (pelecypoda)
- Bilateral symmetry
- 2pieces shell = body covered.
- Plate like gills.
- Examples
  Mytilus edulis (Marine Mussel)
  Anodonta grandis (freshwater mussel)
  Ostrea lurica (oyster)

Cephalopoda
- Bilateral symmetry
- Shell reduced/Internal.
- **Example:**
  Loligo pealii (Squid)
  Sepia officinalis(cuttle fish)
  Octopus bairdi

Deuterostomes (Anus from Blastopore)

Echinodermata (Bipinaria Larvae)

General Characters
- Sea bottom (Marine),5 arms
- Mouth lower surface
- Anus upper surface
- Larval stage = Exhibit lateral symmetry
- sieve like plate, Tube feet
- Madriporite
- No brain/ Nerve ring present
- Separate sexes
- Larval resembles chordates
- **Examples**
  Asterian (star fish)
  Sea urchin, Sea cucumber
  Cake Urchin, Brittle star, Sea lily

Hemichordata (Tornaria Larvae)

General Characters
- Combination of Both Invertebrate + vertebrate
- Pre-chordate
- Body = Prboscis (Protosome) + Collar (Mesosome) + trunk (Metasome)
- Circulatory system
- (Median dorsal + Median Ventral Vessel)
- Respiratory system = Gill slit
- Sub-epidermal plexus
- Nervous system
  Examples
  Balanoglossus
  Saccoglossus kowalevskii

Chordata

Characters
- Notochord
- CNS/dorsal
- Paired gills in embryonic life

Acrania (Protochordata) No cranium

Urochordata
- Notochord + Nerve chord
- Only in free swimming larvae
- Adult are sessile and enclosed in covering =tunic (Tunicin=cellulose)
- Tunicates (Molgula)
- Ciona intestinalis

Larvacea	Ascidiacea	Thaliacea
Oikopleura	Ascidia	Salpa

Cephlochordata
- Notochord + Nerve chord Throughout the life (Amphioxus)

Leptocardii
Branchiostoma (Amphioxus)

Craniata Cranium is present

Vertebrata

Super class Pisces (Aquatic) 48% of total vertebrates More than 29000 species

Cyclostomata (Nofoetal membrane)
- Agnatha
- Most primitive living
- Seven pairs of gills
- vertebrates (Fibrocartilage)
- Without Jaws
- Eal like body
- Scales absent
- No operculum
- No paired appendages
- Heart with one auricle.
  Sexes separate
- (Hamprey)
- sexes same
  (Hermaphrodite, Hag fish)
  External fertilization
  Example
  Lamprey (Petromyzon marinus)
  Hag fish (Maxine glutinose)

Chondrichthyes (Nofoetal membrane)
- Cartilaginous Skeleton
- Placoid scales on body
- J-shaped stomach
- 5-7 pairs of gills.
- No operculum
- No swim bladder
- separate sexes.
- oviparous, viviparous
- Ventral mouth
- **Examples**
  Shark, Skates
  Rays
  Whale
  Sting rays
  electric rays

Osteichthyes (Nofoetal membrane)
- Bony Skeleton
- No placoid scales
- Jaws with or without teeth
- Swim bladder
- 2 chamber Heart
- Brain 10 pairs
- Operculum
  cranial nerves.
  Separate sexes

Dipnoi (Devonian)

Superclass Tetrapoda (Teretrivial)

Veranope (Jurrasic and dominant in Devonian)

Amphibia (Nofoetal membrane) (Tadpole Larvae)
- Double life
- 2 pair of Joint legs
- Bony Skeleton mostly
- Respiration > Lavrae > gills; Adult > Lungs
- 3 chamber Heart
- Separate sexes
- Cold blooded (Poikilothermic)
- **Examples**. Frog, Toad, Salamender

Reptiles
- Ventricle of Heart
- Incompletely
- Partitioned
- Poikilothermic
- Pentadectyle
- Kidney
- Uricotelic
- Flourish in Mesozoic
- Discontents Jurassic
  Examples
  Lizard
  Snake
  Sphenodon

Aves
- Archaeopteryx
- Warm blooded
- Forelimbs wings
- Syrinx
- Flightless (Ostrich, emu, Kiwi, Cassowary Penguin)
- Flight (Pigeon, Sparrow, Parrot, eagle, owl)

Archaepteryx

Mammalia (Cotylosaurs Varanope)
- 4 chamber Heart
- Homeotherms
- oviviparous

Prototheria
- Monotremata
- egg laying
  Example
  Duck bil Platypus (Ornithorhynchus)
  Spiny ant-eater (Tachyglossus)

Metatheria
- Marsupials
- Pouched
  Example
  Opossan
  Kangroo
  Tasmanian wolf
  Koala

Eutheria
- Placenta
- 16 orders!
  Examples
  Man
  Whale
  Elephant
  Horse
  Rat

Insectivora: Moles and shrews.
Chiroptera: Flying mammals, bats, flying squirrels.
Cetacea: Aquatic mammals e.g. whale, dolphin. Porpoises, sea lion etc.
Carnivora: Flesh eating like dog, cat, lion and Wolves.
Rodentia: Cutting habit, rats, mice, squirrel, beavers etc.
Edentata: Adults with no or poorly developed molar teeth like South American anteater, sloths.
Pholidota: Body covered with large, overlapping, horney scales e.g. Pengulin
Proboscidea: Have a long trunk like elephant.
Perissodactyla: Odd-toed hoofed mammals like, horse, zebra etc.
Artiodactyla: Even-toed hoofed mammals like cow, goat, deer etc.
Primates: Mammals withy highest brain development like lemur, monkeys, apes, tarsiers, human beings etc.

Form and Function in plants

Introduction
- Plants→Proper system
- Growth and development throughout life

Plant Nutrition

Macronutrients and Micronutrients

Macro nutrients

Large quantity

- Primary
  - Less in soil
  - More use
  - K,P,N
- Secondary
  - More in soil
  - Less use
  - Ca,Mg,S

O,C,H,N,Ca,K,P,Mg,S

Micro nutrients

ZIMCOS
- Zinc
- Iodine
- Manganese
- Cobalt
- Copper
- Chlorine
- Sodium

Special Mode of Nutrition in Plants
- Parasitic
- Saprophytic
- Carivore
  - Passive trap
    - Pitfall trap
      - Pitcher plants
      - Darlingtonia, Sarracenia → Sarraceniacea
      - Nepenthes → Nepenthaceae
    - Flypaper
      - Sundew (Drosera,Droseraceae)
      - Buttaworts (Pinguicuba, Lentibularicea)
  - Active trap
    - Venus ply trap

Role of stomata in Gaseous Exchange and Transpiration
- Stoma-two Gaurd cells

Dicot: Kidney shape

Monocot: Bell shape

- Inner wall→Thick + Non-elastic
- Outer wall→Thick + Elastic
- Epidermal cell around Guard cell→Subsidiary cells
- Guard cell = Nucleus + Chloroplast

Starch	Mesophyll	Gaurd cell
Day	✓	×
Night	×	✓

- Transpiration→90%→stomata

Transport in Plants

Vascular Tissues and Transport of Materials

Xylem . water Transport

- **Tracheids**
  - 80u wide
  - Secondary lignified cell wall
  - Mature→No nucleus
  - Functional cells are surrounded by support and storage cells e.g Parenchyma , fibers and sclereids
  - Water movement by pits
- **Vessel elements**
  - Characteristics of Angiosperm
  - Wider + shorter+ thinner walled
  - Water movement=Pits + perforation

Phloem . (Organic solute)

(Outer to xylem)
(5 different types)
- Phloem parenchyma
- Phloem ray cells
- Sieve tubes
- Companian cells
- Phloem fibers

Sieve tube cells
- Wall cellulose
- Sieve plate

Companion cell
- Living cell
- Communicated with sieve tube by Plasmodesmata
- Present in Angiosperms

Transport in Plants

Water status in plants

Water potential
- Water potential α conc. of water Molecules
- ψ
- Water potential=Solute potential + Pressure potential

Solute or osmotic potential
- Measure of change of water potential by addition of solute
- ψs (K_{pa})

Pressure potential
- Represented by turgor cells
- ψp

Movement of water through roots

Call wall→Cortex→endodermis
Pericycle → xylem cells

Apoplast Pathway
→Inter connecting cell walls + Intercellular spaces.
→Non-living pathway

Symplast
→Protoplast to Protoplast
→Living pathway

Vacuolar or tanscellulary Pathway
→Vacuole→Vacuole
↓
Plasmodesmeta

Water potential in xylem wrought TACT Mechanism

Transpiration
Adhesion
Cohesion
Tesion (-ve fore)

Mechanism of opening and closing of stomata

Sugar starch theory
$CO_2+H_2O \rightarrow C_6H_{12}O_6+O_2$
- Co_2→H+↓→starch+Phosphatase→ Glucose+phosphate
- Increase osmotic pressure in cell also increase diffusion pressure
- Deficit→Water in guard cell
- Opening
- Closing vice vera

Theory of K+ Ion
- Starch→Phosphorylated hexose→ phosphoenol pyruvic acid + CO2→ Malic Aicd→Malate Ion + H+] Guard cell Day
- Role of Abcissic Acid

Transport in Plants

Translocation of organic solutes

- Green leaves = Source of assimilates
- Buds, seed, fruits, roots + underground Stem = sinks of assimilates

Pressure flow mechanism
- Water+ Sucrose but also Hormones + A.A

Pressure flow or Mass flow Hypothesis
- Sugar→companian cell→ (Active transport ↓) sieve tube

Homeostasis in plants

- Isotonic + Hypotonic + Hypertonic solutions

Osmoregulation in Plants

Hydrophytes
Hydrilla,
Vallisneria
Potagnogeton

Mesophytes
Citrus
Brassica
Pea
Peach
Rose

Xerophytes
Leaves into spine,
Thorns
Cactus
Opuntia
Aloe,
Rscus
Acacia
Calotropis
Zizyphus

Halophytes
Mangrove
Salt Tolerant
Salsola (Saltwort)
Rhizophora

Adaptation of plants to low and High temperature

- Metabolism slow → ↓Temp / ↑ Temp
- Extreme Higher Temp→Injury
- Freezing temp→Ice Crystal

Low Temp
- Well develop bark + short life cycle
- Change the conc of solution to super chill
- Leaves + stem can withstand low temp.
- Scale leaves
- Rate of transpiration low

Hight Temp
- Branching system for water
- Evaporation cause cooling
- Thick cuticle
- Spines to reduces
- Heat shock proteins

Support in plants

- Support→Mechanical tissue

Collenchyma
- Turgor pressure
- Plasmolysis
- Deplasmolysis

Sclerenchyma

Structure of Supporting tissue in plants

Collenchyma
- Growing plant parts
- Young tissue
- Leaves + elongated stem
- Unequal thick primary wall
  - Angular
  - Annular
  - Lamellar
  - Lacunar
- Non lignified thick primary wall
- Parenchyma + collenchyma common common Characters→Chloroplast + Meristem activity

Sclerenchyma
- Hard + non-living

Fibers
longitudinal
Meristematic
Xylem
Lignified always

(Rise = Association; that do not belong to xylem bast)

Sclereids
variable
Parenchyma
Stone cells in pears

Transport in Plants

Growth and development in plants

- Growth→Increase in number and size of cells

Cell division

- Meristem tissues

Apical (Monocot + Herbs)

- Tips of root and shoot
- Protoderm →epidermis
- Ground meristem →Cortex
- Procambium
  - → Primary Vascular tissue
  - → Primary Phloem
  - → Vascular Cambium
  - → Primary Phloem
- Central ground meristem →pith

Leteral

- Gymnosperms + dicot
- Vascular combium
  ↳vascular tissue
- Cork combium
  ↳Cork
- Some plants
  Parenchyma cells
  ↓
  Cork combium

Elongation

Cell Mutation

Cell Differentiation

Growth Correlation

Apical deminance

Complete
Only main shoot grow
Sun forever

Incomplete
Tomato

Annual rings

- Summer +Trouble→Thin layer
- One annual ring=Ring of early wood+ring of late wood.
- Outside→Phloem
- Inside→Xylem

Growth Responses in plants

Auxin
- IAA→Auxin
- Elongation of cells
- Initiate cell division in cambium
- Inhibit growth in lateral buds

Gibberellins
- Dwarf→Normal
- Seed germination
- Break seed dormancy

Cytokinins
- Cell division
- Chemically→Nucleic acid
- With auxin→Cell division in plant tissue culture.
- Lateral growth
- Delay senescence by protein synthesis

Abscisic acid
- Bud+seed dormancy
- Stress hormone

Ethylene
- Inhibit root growth
- Induce fruit ripening

Plant Movement

- **Growth Movement (External)**
  - **Autonomic (whole plant)**
    - **Expinasty** – Upper more growth
    - **Hyponasty** – Lower More growth
    - **Nutation** – Zig zag manner
  - **Paratonic (Part of plant)**
    - **Tropic Movement**
      - Geotropism
      - Phototropism
      - Hydrotropism
      - Thigmotropism – Tendrils
      - Chamotropism – Egg → sperm, Pollen tube
    - **Nastic Movement**
      - Non-directional
      - Depend upon variation of Intensity
      - **Photonasty** – Intensity of Light
      - **Thermonasty**
      - **Seismonasty** – Mechanical
    - **Tactic Movement**
      - **Phototactic** – Toward light (Volvox)
      - **Thermotactic** – Algae to warm side
      - **Chemotactic** → Spermatozoid
- **(.........) .... Movement**
  - **Rapid**
  - **Sleep**

Transport in plants

Photoperiodism

Short
- Tobacco
- Dahlia
- Soya bean
- Chrysanthemum

Long day plant
- Hibiscus
- Beet
- Spinach
- Potato

Day neutral plant
- Maize
- Tomato
- Sun flower
- Cucumber

Phytochromes

Red light

Pr 660 nm → Pfr(Achtive)

└Flowering in long dary plants

Far-red (730 mm)

Florigen→Leaves

Vernalization
- Low temp treatment
- Buds
- Vernalin

Digestion

Introduction
•Food and drinks are broken down into their smallest parts to provide energy.
1.Digestive tract
2.A series of hollow organs joined in a long tube extending from mouth to Anus.

Mechanical and chemical digestion in the oral cavity
•Small manageable pieces by masseter and temporalis muscles.
•Mastication causes secretion of saliva.
•Saliva moistens for swallowing
•Digestive enzymes (e.g. salivary amylase), breakdown of carbohydrates.
•Chewing increases surface area
•Lingual lipase by **Ebner's glands** on the dorsal surface of the tongue.

Swallowing process
Stage 1: The Oral Stage
•Tongue pushes a piece of chewed food to back of your throat and into the opening of the esophagus.
•Soft palate closes off the nasal cavity, epiglottis tilts downward to seal the trachea.
•Choking;It involves a sudden forceful expulsion of air through the larynx.
Stage 2: The Pharyngeal Stage
•Larynx lifts up to meet the epiglottis.
Stage 3: The Esophageal stage:
•Bolus is passed into the esophagus by automatic contractions of the pharynx. to the stomach by gravity and reflex action.

Peristalsis
•Food towards the cardiac sphincter by smooth muscle. Food travels from the mouth to the stomach in about **4 to 8 seconds.**

Stomach(Structure of stomach)
•"J" Shape in the middle of the chest behind the liver, between the esophagus and the first section of the small intestine (the duodenum).
• 4 regions each
(1)The Cardiac region
(2)The Fundus
(3)The Body
(4)The Pylorus.
• Gastric glands, secrete 400-800 ml of gastric juice at each meal.

Several kinds of cells are found in the gastric glands
i)Parietal cells
ii)Chief Cells
iii)Mucus-secreting cells
iv)Hormone-secreting (endocrine) cells
a.Parietal Cells:
• Hydrochloric acid
The concentration of H+ in the gastric juice can be as high as 0.15 M
giving gastric juice a pH somewhat less than 1.
• Intrinsic Factor
Binds with ingested vitamin B12 .
b. Chief Cells:
Synthesize and secrete pepsinogen.
c. Mucus secreting cells:
Prevent damage from gastric acids.
d. Hormone secreting cells:
Stimulated by the hormone gastrin.

Absorption in the stomach
•Water, certain ions, and drugs like aspirin and ethanol
Functions of the stomach
•Stores food.
•Breaks large protein molecules
•pH 1-3 also kill bacteria in the food.
•Churning
•Emties chyme into the duodenum.
•Absorption of iron and highly fat-soluble substances like alcohol are absorbed directly.

Digestion

(1)Mechanism of Secretion of Gastric Juice:
Sight, smell, and taste or hearing of delicious food stimulate the nervous system
Gastrin
Protein molecules stimulate the endocrine cells

(3)Small Intestine
Longest section of the digestive tract (approx. 17 feet)
♦Duodenum
♦Jejunum
♦Ileum
Functions
•Peptides→ amino acids.
•Lipids→fatty acids and glycerol.
•Carbohydrates → glucose.
Bile(liver),
•Pancreatic juice (Mmylase, maltase, lactase, sucrase)
Duodenum:
•Superior, descending, horizontal and ascending duodenum.
•Chyme is mixed with fluids from the gallbladder (bile) and pancreas (pancreatic juice).
•12 fingers or inches.
Jehunum:
•4-7 feet in length,chemical breakdown of the food chyme.
Ileumn
•7-5 feet in length.
•Absorb nutrients.(Also bile then to liver by blood vessels)

(2)Absorption of nutrients in small intestine:
Villi are present studded with millions of microvilli.
Lacteals and blood vessels (capillaries)
lacteal lymph vessel absorbs digested fat into the lymphatic system.
Blood vessels receive nutrients and transport them via the hepatic portal vein to the liver. blood is filtered, toxins are removed and the nutrients are processed.

(4)Large intestine:
Water absorption.
Structure
Regions
•Cecum (or caecum)
•Colon the longest segment (Ascending colon, transverse colon, descending colon and sigmoid colon)
•Rectum is the final part of the large intestine.
•Aanal canal collects faeces from rectum.
•External sphincter relaxes for fecal discharge.

Liver:
•Largest organ in the human body.
•Central position of the abdomen.
Functions are:
a. Carbohydrate Metabolism:
•Glucose level in response to insulin and glucagon.
•Glucose into glycogen and glycogen back to glucose.b.
b.Fat metabolism:
•Synthesizes lipoproteins, cholesterol and phospholipids
c. Protein Metabolism:
•In the hepatocytes, Urea cycle.
d. Detoxification:
•Kupffer cells digest and destroy cellular debris and any invading bacteria.
•Drugs and alcohol are detoxified by the liver.
•Some hormones are inactivated.
•Bilirubin
e. Storage:
•Vitamins(A, B12, D, E, K)+ minerals(iron and copper)
•Glycogen
f. Bile:
•Important for fat digestion.
(Water, bile salts, cholesterol, phospholipids, electrolytes and bile pigments) yellowish-green-colour.
•Stored and concentrated in the gall bladder and released into duodenum when required.

Digestion

Pancreas

•Elongated organ, light tan or pinkish in color, lies in close proximity to the duodenum.

•Three regions:
The head
The body
The tail

The head:

•Lies C-shaped region of the duodenum
Connective tissue, connected by a common blood supply.

The body and Tail:

•Extend across the midline of the body towards the hilum of the spleen.

•Pancreatic juice empties ampulla of Vater.

Structure of Pancreas:

Pancreas anatomy has two main components
(1)Exocrine cells
(2)Ducts

•Islets of langerhans

•Acinar cells secrete the digestive enzymes.

•Ductular system consists of a network of conduits that carry the exocrine secretions into the duodenum.

•Accounts for only 2% of the pancreatic mass

•Alpha (A) cells secrete glucagons.

•Beta (B) cells secrete insulin

•Delta (D) cells secrete somatostatin.

•F cells secrete pancreatic polypeptide.

Functions of Pancreas

•Neutralize gastric acid and regulate the pH of the intestine.

•Acinar cells secrete isozymes like amylases, lipases and proteases.

•Amylase secreted in active form.Hydrolyzes starch and glycogen to glucose, maltose, maltotriose, and dextrins.

•Lipase emulsifies and hydrolyses fat in the presence of bile salts.

•Proteases are essential for protein digestion.

Relation of bile and pancreatic juice with the secretin hormone

Secretin:First hormone to be discovered.
Secretin stimulus: acidification of the duodenum.
Principal target for secretin is the pancreas, responds by secreting a bicarbonate-rich fluid to neutralize the acid.
As acid is neutralized by bicarbonate, the intestinal pH rises toward neutrality, and secretion of secretin is turned off.

DYSPEPSIA

Recurrent and persistent indigestion

Symptoms of Dyspepsia:

Pain in the upper abdomen, often made worse by eating, and nausea, particularly in the morning.

Treatment for Dyspepsia:

Blood test for bacterium H. Pylori.
Upper digestive tract endoscopy or contrast X-Rays may be carried out to look for abnormalities in the gastrointestinal tract.

Prevention of Dyspepsia:

Eat less at regular intervals, without eating too fast or overfilling your stomach.
Avoid eating in the three hours before going to bed.
Avoid rich, fatty foods such as butter and fried foods.
Learn to overcome stress, which can often trigger episodes of abdominal discomfort.
If overweight, try to reduce weight and avoid tight fitting clothing.
Avoid medicines such as aspirin and other non steroidal anti-inflammatory drugs.

Disease	Introduction	Causes/Sign and symptoms	Treatment
ULCER	Stomach problem	•Injury of the gastric mucosal lining,•Excess secretion of hydrochloric acid, •Genetic predisposition, •Psychological stress, •Excessive use of asprine •Smoking •By hydrochloric acid, •Infection with Helicobacter pylori **Sign and symptoms** •Nausea, pain in abdomen, flatulence, burning in chest region	•Antibiotics to kill the bacteria • Acid suppressor
OBESITY	•If the food we eat provides more calories than our body needs, the excess is converted to fat. •Initially, fat cells increase in size. •When they can no longer expand, they increase in number.	·Age, diet, sex, and genes, psychological makeup, and environmental factors all may contribute. Genes and Environmental factors ·Obesity tends to run in families. ·This is caused both by genes and by shared diet. The most important environmental factor is lifestyle. Age and Sex:·People tend to lose muscle and gain fat as they grow older. ·Women are more likely than men to gain weight with the same calorie intake. Emotions:·Some people overeat because of depression, hopelessness, anger, boredom, and many other reasons that have nothing to do with hunger. Pregnancy:·Women trend to weigh an average of 4-6 pounds more after a pregnancy. Medical Complications ·Hypothyroidism, Cushing syndrome, Depression. Obesity is associated with type 2 diabetes, hyperlipidemia, coronary artery disease, arthritis, gallstones, psychosocial disability.	•Exercise •A low-fat, carbohydrate and high fiber diet •Behavior modification to change eating behavior •Social support •Medications
BULIMIA NERVOSA	Bulimia is associated with depression and other psychiatric disorders and shares symptoms with anorexia nervosa, another major eating disorder	**Sign and Symptoms:** •Being eating of high carbohydrate foods, usually in secret•Exercising for hours •Eating until painfully full•Going to the bathroom during meals •Body weight that goes up and down•Constipation, diarrhea, nausea, abdominal pain •Dehydration•Irregular menstruation or lack of menstrual periods in females •Damaged tooth enamel, bad breath, sore throat or mouth sores •Depression	•Psychotherapy is a cornerstone of bulimia treatment. •Yoga, tai chi, and meditation, may help. •Antidepressants are often prescribed for bulimia.
ANOREXIA NERVOSA	Emotional disorder in which patient feels over conscious about body weight(teen).	**Signs and Symptoms:** •The primary sign of anorexia nervosa is severe weight loss. They may also exercise excessively. They may vomit after eating or take laxatives. At the same time, the person may insist that they are overweight. **Physical Signs:** •Excessive weight loss,Very rare menstrual periods,Thinning hair, dry skin,Bloated or upset stomach,Low blood pressure,Fatigue,Abnormal heart rhythms,Osteoporosis **Psychological and Behavioral Signs:** •Anorexia patients refuse to eat and also refusing to acknowledge the seriousness of the illness.They suffer from depression and refuse to eat in public. Such patients constantly weigh themselves and do regular exercises.	•The most successful treatment is a combination of psychotherapy, family therapy, and medication.
FOOD POISONING	Sudden illness caused by eating food or drinking liquids contaminated by a toxin or infectious organism.	**Cause of Food Poisoning:** Contamination of food or water by bacteria viruses or, less commonly, protozoan parasites, toxins produced by the bacteria. **Symptoms** The symptoms may start hours or days after consuming the contaminated food. Diarrhea, vomiting, nausea, abdominal discomfort, dehydration are the most common symptoms. In very rare cases, there is a risk of septicemia if bacteria spread into the blood stream. **Major food Poisoning Agents:** •Staphylococci•Escherichia Coli•Salmonella•Campylobacter	**Treatment of Food Poisoning:** In severe cases fluids and salts may be administered intravenously in hospital. Typically, antibiotics are prescribed only if specific bacteria have been identified.

Circulation

- Circulatory system (Transport system)
  - Cardiovascular system
  - Lymphatic system
- Human Blood circulatory system
  - Heart
  - Blood vessels
    - Arteris
    - Capillaries
    - Veins
  - Blood

Heart

Structure

- Muscular pumping organ.
- Conical, size of your tightened fist.
- Left side of the thoracic (chest) cavity.
- Covered by a tough double membrane called pericardium.
- Pericardium: Prevent Over extension especially when hard exercise.
- Pericardial cavity filled with a fluid, the pericardial fluid
- Cardiac muscles

Character	Atrium (Right, Left)	Ventricles (Right, Left)
Size	Smaller, Thin walled	Larger, Thick walled
Septum	Inter auricular septum	Ventricular septum
Valve	Tricuspid between right atrium/ventricle (3 Flaps)	Bicuspid between Left atrium/ventricles (2 Flaps)

Cardiac cycle and phases of heart beat

- On contraction and one relaxation is called a cardiac cycle.
- Contraction of heart is termed as systole and relaxation as diastole.
- One complete cycle takes 0.8 seconds.
- The contraction and relaxation are cyclic and rhythmic.

First phase
- Diastole
- Blood flows in 4 chambers passively

Second Phase
- Systole 0.1 Seconds
- Both Auricles contract, push blood toward ventricles

Third Phase
- Ventricle Systole 0.3 Seconds
- Ventricles pushes blood toward aorta and pulmonary artery.

SA Node (Sino Atrial)

At upper wall of right atrium, near entrance of superior vene cava

Generate impulse faster, responsible for whole heart's activity	Primary pacemaker

Impulse flows from SA Node toward AV Node

Electrical signals from the atria must pass through the AV node to reach the ventricles.	According to **encyclopedia Britannica** electrical relay station between the atria and the ventricles.

AV Node	Purkinji Fibers
AV node Cordinate Heart rate, Electricaly connected to artium and ventricle.	Specialized myocardial fibers, conduct electrical signals to areas of heart to work in a coordinated way.

ECG

Circulation

Heart | **Blood vessels** | **Blood**

Heart

- Electrocardiogram (ECG) medical device
- Placed on the chest skin at specific locations.

Uses of ECG:

- Electrical workings of the heart,Heart rate,Arrhythmias
- Myocardial infarctions, Atrial enlargements
- Ventricular hypertrophies,Bundle branch blocks

ECG

- Overall electrical current towards a particular lead, it registers a positive deflection.
- Away from the lead register a negative deflection. 90 degrees or perpendicular to the vector of the lead registers 0, i.e. is seen as an isoelectric line.
- The rate of paper 25 mm/s which results in:
- 1 mm = 0.04 sec (or each individual block)
- 5 mm = 0.2 sec (or between 2 dark vertical lines)
- 1 mm = 0.1 mV (or between each individual block vertically) this results in:
- 5 mm = 0.5 mV (or between 2 dark horizontal lines)
- 10 mm = 1.0 mv (this is how it is usually marked on the ECG's)

Reading ECG

- QRS wave
- TP Interval (Ventricular Diastole)
- P Wave (Atrial Systole)
- QR Interval (End of Ventricular Diastole)
- RS Interval (Ventricular Systole)
- ST Segment (Ventricular Systole)
- T Wave (Ventricular Diastole)

Blood vessels

Arteris | Capillaries | Veins

Feature	Arteries	Veins
Definition	• Carry blood away from heart	• Carry blood toward heart
Type of blood	• Oxygenated except pulmonary artery	• Deoxygenated except Pulmonary vein
General characteristics structure	• Very elastic • Resist flow of blood • Ventricle pumps the blood and maintain constant flow of blood	• Less elastic • Do not bear systolic pressure • Valves prevent backward flow of blood, skeletal muscle push blood like massaging action
Blood Pressure	• Average BP 100mm Hg	• Average BP 2mm Hg
LAYERS **Tunica Externa**	• Areolar Tissue + Elastic Tissues • Provide elasticity to expand • Vasa Vasorum (network of vessels which provide blood supply to cells of large vessels)	• Same as Arteries but contain less elastic fibers
Tunica Media	• Circular smooth muscles control diameter • Elastic Fibers	• Middle layer is thin as compare to that of arteries.
Tunica Intema	• Squamous Epithelial cells • Areolar Connective Tissue	• Same as arteries
Branches	• Aorta (Largest Artery arise from left ventricle and bends down from left side to gives branches) • Arteries • Arterioles (3mm-10µm diameter) • Large contain 3 Layers as artery • Small contain 2 Layers (Endothelial+Smooth muscles)	• Vena Cava (Superior, Inferior) • Veins • Veinoles (8-100µm Diameter)
Control of Diameter	• Sympathetic Nervous System cause contraction of smooth muscles of arterioles, decrease blood flow in capillaries, BP increases • When Blood flow increase due to vasodilatation BP decreases.	• Rarely Change diameter

Capillaries

- Smallest blood vessels
- Thin that only one RBC passes through .
- Precapillary sphincters (band of smooth muscle).
- Capillary pressures high (and this can be the result of gravity), fluid passes out of the capillaries into the interstitial space and edema or fluid swelling is resulted.

Circulation

Path of blood through Pulmonary and systemic circulation

- Pulmonary circulation → systemic circulation.
- Two-circuit system .
- Double circuit heart

Exchange of materials

- Transport of oxygen and nutrients remove the metabolic waste
- Transport metabolic waste back to the organs responsible for their excretion.

Oxygenation of Blood

- oxygen binds to the heam part
- Blood also absorbs nutrients, (Glucose)

Pumping of Oxygenated Blood

- Aorta→ branching arteries → arterioles →Capillaries→Veniloes→Veins

Interstitial fluid

- Water also oozes out of the capillaries as interstitial fluid

Control of capillary bed

- 60,000 miles of capillaries,
- Surface area of some 800-1000 m2
- Total volume 5 liters, the same as the total volume of blood in human body.
- Increased blood supply to the skin dissipation of the heat produced by the muscles.
- Blood supply to the brain remain constant.

Blood pressure:

- Pulsation can easily be felt in those arteries (like radial artery)
- Pulse→ pressure of the blood which makes the elastic layer of arteries to expand rhythmically allowing blood to pass through.
- Force per unit area that blood exerts on the inside walls of a blood vessel is called blood pressure.(mm Hg).
- Sphygmomanometer.

Types: Blood pressure is of two types.

- Systolic blood pressure which felt during the ventricular contraction.
- Diastolic blood pressure which is felt during ventricular relaxation.

Systolic B.P

- Greater than the diastolic pressure.
- Blood pressure → contraction of the left ventricle.
- Pressure is highest in the aorta
- In capillaries the difference between systolic and diastolic pressure disappears.
- In capillaries the B.P. is about 40 mm Hg.
- It decreases to less than 20 mm Hg when the blood leaves arteries and further drops in venuoles.
- 0 mm Hg when it enters the right atrium from upper and lower vena cavae.

Sensory Receptors for Controlling BP:

- Blood vessels → Baroreceptors. work as short term blood pressure regulation mechanism.
- Baroreceptor can be divided into two categories
(1)High pressure arterial baroreceptors
(2)Low pressure baroreceptor
(also known as cardiopulmonary or volume receptors

High pressure arterial baroreceptors

- Aortic arch + Carotid sinuses of the left and right internal carotid arteries.
- Aortic arch blood being delivered to all the blood vessels via the systemic circuit
- Carotid arteries monitor the blood pressure of the blood being delivered to the brain.

Low pressure baroreceptors

- Large systemic veins + walls of the right atrium of the heart.
- Regulation of blood volume.
- Circulatory + renal effects

Organs	At Rest	During Strenuous Exercsie
Heart	250	750
Kidneys	1,200	600
Skeletal Muscles	1,000	12,5000
Skin	400	1,900
Viscers	1,400	600
Brain	750	750
Other	600	400
Total	5,600	17,500

Name of Vessel	Systolic B.P.	Diastolic B.P	B.P
Arota	120	80	
Arteries	102	60	
Arterioles	60	45	
Capillaries	-	-	40
Venules	-	-	20
Veins			10
Vena cava			0

Cardiovascular disorders

Thrombosis and embolism

Thrombosis

Aggregation of platelets inside vessels.

Embolism coined by Rudolph Carl Virchow in 1848

- A Thrombus which dislodges and becomes free-floating is termed as an embolus.
- Myocardial infarction
- If block artery to brain cause Stroke, Cause death or paralysis.

Risk Factors:

- Atrial fibrillation
- Heart valve replacement
- Recent heart attack
- Extended periods of inactivity
- Genetic factors
- Generally bed ridden patients

Atherosclerosis and Aleriosclerosis

- Atherosclerosis: (Gr. Arthere = porridge, skeleoris = hardening)

=wall of artery thickens as the result of deposition of fatty materials such as cholesterol.

Causes

- low-density lipoprotein molecules (LDL)
- Oxidized LDL
- Macrophages and T-lymphocytes to absorb the oxidized-LDL.
- Typically begins in early adolescence.
- Anatomic, physiological and behavioral factors
- Hyperlipidemia (High level of fats in blood), hypertension and cigarette smoking together increases the risk even times.

Treatment of Atherosclerosis

- Stop smoking
- Change feeding habits
- Daily exercise or at least daily walk.
- Medicines are usually the next step.

Physical treatments

- Angioplasty procedures (Stents)
- Invasive surgery, (bypass surgery)

Causes:

- Stiffening or loss of elasticity of arterioles
- Hypertension
- Site:Arteries in the brain, kidneys, heart, abdominal aorta or legs.

Symptoms:

- Leg pain,Sudden weakness or dizziness, Chest pain

Risk factors for arteriosclerosis

- Smoking•Obesity•High blood pressure
- High serum cholesterol•Stress•Diabetes
- Family history of early heart disease

Congenital Heart problems

- Defect is a defect in the structure of the heart and large blood vessels of a newborn baby.
- Affecting the heart rhythm.

Septum Defects

- Wall of tissue → left side of the heart from the right side of the heart.
- Septum between the atria or the septum between the ventricles.
- May not cause cyanosis.

Obstruction Defects:

- Heart valves, arteries, or veins are abnormally narrow or blocked.
- Blockage of pulmonary valve, aortic valve and bicuspid aortic valve.
- Any narrowing or blockage can cause heart enlargement or hypertension.

Blue baby or Cyanosis

- Physiological condition called cyanosis.

Reason=formation of carboxyhaemoglobin

- Duing the embryonic life, heart of the foetus start beating after four month of gestation.
- In the heart of the foetus, an opening, "foramen ovale" connects the right atrium with left atrium.
- The blood passes from right atrium to the left without passing through lungs.
- The reason for this bypass is that the supply of oxygen to the foetus is from the blood of the mother through placenta (and not by lungs)
- After the birth the foramen ovale closes spontaneously but in some babies it does not close completely.
- When the baby exerts force during crying and movement the deoxygenated blood from the right atrium enters the left atrium through the partially opened foramen.
- When the haemoglobin of this venous, deoxygenated blood turns to carboxyhaemoglobin, it impart blue discoloration to the skin, lips, ears and other organs of the body, resulting in cyanosis or blue baby.

Hypertension

Cardiovascular disorders

Hypertension
- Persistently from high blood pressure.
- Normal BP= 120/70 mm Hg
- Hypertension= 130/90 mmHg
- Women of above forty five years of age BP of 160/95 is considered hypertensive
- Whereas for a man this limit is 140/95 classified as

Persistent hypertension
- Risk factors=strokes, heart attacks, heart failure and arterial aneurysm, and is a leading cause of renal (kidney) failure.

Moderate elevation
- Shortened life expectancy.

Severely high pressures,
- Defined as mean arterial pressures

Mild to moderate essential hypertension
- Greatly asymptomatic.

Complications of High blood pressure:
- Headache
- Somnolence
- Confusion
- Nausea
- Vomiting
- Retinas Damage
- Chest pain
- Shortness of breath
- Irregular heartbeat

Prevention and Treatment of Hypertension
- Calcium intake has the benefit of increasing dietary potassium, which theoretically can counteract the effect of sodium and act on the kidney to decrease blood pressure.
- Fruits + vegetables + low-fat or fat-free
- Discontinuing use of tobacco and alcohol
- Reducing stress and tensions are also effective
- Antihypertensive medicines are also used.

Essential or primary hypertension

No medical cause of raised blood pressure.
90-95% of hypertension is essential hypertension

Secondary hypertension

Another condition, such as kidney diseases, Cushing's syndrome, or tumors.
Ibuprofen and steroids
Sleep disturbance and pregnancy

Hypotension
- Abnormally low blood pressure.
- Physiological state, rather than a disease.

Symptoms:
- Dizziness
- Fainting
- Seizures

Causes:
- Hemorrhage (blood loss)
- Insufficient fluid intake (as in starvation),
- Excessive fluid losses from diarrhea or vomiting
- Excessive use of diuretics
- Some medicines

Angina pectoris, Heart attack and Heart Failure
- Severe, radiating chest pain due to the lack of blood supply to the heart muscle.

Causes/Symptoms:
- Atherosclerosis
- First alarm of the body
- People survive in first two attacks but mostly third attack is fatal and results in heart failure.

Treatment of cardiovascular disorders

Angiography

Angiogram → check the condition of blood vessels.

Angioplasty

Widening a narrowed or obstructed blood vessel.

Procedure of Angioplasty:

Balloon-tip catheter

Beating Heart Bypass

Successful graft 10-15 years

Open heart Surgery

Chest is opened and surgery is performed

Lymphatic system

Introduction
- Carry a milky fluid called lymph.
- Lymphoid tissue through which the lymph travels.
- Tissues of the body to blood.
- 1652 First described by a Swedish Olaus Rudbeck (1630-1702)
- Thomas Bartholin given the name of lymphatic vessels.

Lymph Nodes:
- Masses of connective
- More than 100 in human body armpits, groin and neck region.
- Sites of lymphocyte production and storage.
- Barriers to infection by filtering out
- Largest lymphoid organ spleen.

Position of lymph nodes:
(1)The cervical region
(2)The axillary region
(3)Inguinal region
(4)The pelvic cavity
(5)Abdominal cavity
(6)Thoracic cavity

Lymph Vessels:
- lymphatic trunks → lymph → larger areas of the body.
- The "intestinal trunk" drains organs of the abdominal cavity; the "lumbar trunk" drains lymph from the legs, lower abdominal wall, and the pelvic organs; the "intercostal" and "brochomediastinal trunks" receive lymph from portions of the thorax; the "subclavian trunk" drains the arm; and the "jugular trunk" drains parts of the neck and head
- These trunks then join one of two collecting ducts:
  (a) the thoracic duct or
  (b) the right lymphatic duct.
  Drain → subclavian veins.

General Functions of Lymphatic System:
1. Villi in the small intestine absorb products of fat digestion i.e. fatty acids.
2. Distribution of fluids and nutrients in the body.
3. Eliminates the products of cellular breakdown.
4. This is important to the body's' defense mechanisms.
5. Make antibodies.
6. The spleen, clearing worn out red blood cells

Lymphatic system and cancer
Important in diagnosis, prognosis, and treatment of cancer.
Carrying cancerous cells between the various parts of the body

Diseases of lymphatic system
- Diseases, infection
- Impair the body's ability to fight infections.
- Hodgkin's disease

Interstitial Fluid
- Blood vessels are joined by Capillaries.
- When the blood passes with pressure water along with certain salts, some plasma proteins etc. ooze out in tissue spaces.
- It is simply blood plasma minus most of the proteins. It has the same composition as the glomerular filtrate in kidneys.
- This bathes the cells in the tissue space and substances in it can enter the cells by diffusion or active transport. Substances, like carbon dioxide, can diffuse out of cells and into the interstitial fluid.

Lymph
- From here this fluid is collected in the fine, very permeable, blind ended capillaries of lymphatic system in the form of lymph which join to make larger vessels. The lymphatic vessels transport this excess fluid to the end vessels without the assistance of any "pumping" action.

Immunity: Body & Response to antigens :- Bacteria, Virus. Parazoans, other Parasites
Autoimmunity: Against own's proteins and aberrant cells, tumor immunity.

First line, of Defense => NON-SPECIFIC

Skin

Functions
- Largest Integumentary Organ
- Biological barrier
- Insulation, Sensation, temperature + water regulation

Chemical composition

(a) Perspiration
- Sweat Gland
- Highly saline
- Lysozymes ruptures bacterial cell wall

(b) Sebum
- Sebaceous Gland
- Oily and acidic media
- Inhibits growth of pathogens

Involves Epidermis
- Multiple layers
- Highly packed cells
- Shedding of dead cells and pathogens
- Dendric cells for phagocytosis

Dermis
- Beneath Epidenmis
- Collagen resistant to abrasions and & penetration

Cilia, And Mucus

Filteration
- Via nose, hairs and cilia
- Mucus traps pathogens and dust
- Sneezed out via nose

Warming
- Blood vessels in nose
- Surface area
- Prevents sensitive tissues in lungs

Functions
- Moisture
- Prevents from drying

Digestive Tract
- HCl in stomach
- Acidic media
- Friendly Bacteria in gut

Mucus of Bronchi
- Respiratory tract Nose, Mouth→trachea→bronchus →bronchioles→alveoli of lungs blood Strom
- Airways produce thin coat of mucus for trapping
- Pathogens swept up by cilia in bronchi and trachea
- Coughed up or swallowed

Second Line of Defence: Non-Specific

Properties	Macrophoges	Neutrophils	Nk cells	Complementary response	Inflammatory response	Pyrexia	Interferons
General	•Largest blood cells •Monocytes is the immature form, produced in bone morrow	•Small sized •Produced in bone marrow	•Lymphoytes •Cytotoxic •Part of innate immunity •Host Rejection	•WBCs, Proteins •Antibodies	Symptoms: Redness warmth, swelling, pain	Elevated body temperature Regulated by feedback mechanism	Antiviral Proteins Types→Alpha, Beta →produced by fibroblasts, connective tissues →Gamma→Sproduced by activated T.Cell
Function	•Cleans up dead Neutrophils and pus •Found in bloods stream and boundary tissues e.g alveolar mocrophages	Releases H_2O_2 and enzymes on pathogens •Found in small capillaries •Phagocytosis •Makes pus	•Perforin causes pores.(proteases) •Gramzymes induces apoptosis •Cell lysis→ Breaking of cells to release virions.	•Covers the bacteria with antigens •Binds it to toxins •Debris is sent to T & B cells for specific antibody response.	•Leakage of blood vessels •Tissues releases histamine, serotonin •Separates the infectious area •Phagocytosis	•Stimulates immune system •In hospitable condition for growth **Benefits** •Walling of iron •Improved response •More WBCs and antibodies made	•Viral Nucleic acid enters cell→interferon genes released→1st host cell is killed→2nd host cell releases antiviral Protein against replicating virus •Releases →Macrophages →Neutrophills →T Cells →Display MHC I & II
Causes , activation or release	Pathogens	Pathogens	Activated by interferon and cystokines	•Macrophages •Surrived Bacteria	•Injury, toxins pathogens, trauma	•Pyrogens: Lipopoly sacchrides •Bacterial, viral, fungal toxin endo & exotoxins	•Activated by fibroblasts and T cells

Types of Immunity

Innate
- Inborn
- Inherited from mother to offspring via placenta

Acquired
→Developed during ones life
→In response to disease
→Can be permanent or temporary
→Stored in memory cells

Types

Artificial
→Borrowed from another source
→Antibodies aquired from mother's milk

Natural
→Long lasting, developed by body's own cells
(1) By disease exposure
(2) Subclinical Infection
(3) Killed or detoxified microbe. (vaccination)

Vaccination:
→Enhances immune systems response
→Develops memory cells
→Cowpox first vaccine discovered by Edward Gunnar
→Vaccine of cowpox gives immunity against small pox

Third line of Defense: Specific Response

Cell Mediated Response:
- Involves T-cells

Originate in bone marrow | **Mature in thymus**

- **Types**
  - Cytotoxic Tc, kills invader directly
  - Helper Tc, aid B-cells
  - Supressor Tc, supresses the over activity

2 Phases

Activation
- Appropriate T-cells are activated
- Macrophoges digest infections and display surface proteins for activation of Tcells

Effector
- Contains perfoins
- Which are released by T-cells on target cells and kill them

Antibody Mediated Response:
- Involves B cells
- They originate and mature in bone Morrow
- Activated by exposure to cell surface markers
- Cell surface markers are oligosachrides and proteins
- Mechanism

(a)B cells produce antibodies
(b)Pathogens activates B cells with matching receptors and also T cells
(c)B cells are aided by Helper Tcs and macrophage
(d)B cells forms

Memory cells
- Activation killer B and kills T cells when exposed to any pathogen later on

Plasma cells
- Makes antibodies
- Marks the destruction of pathogens

Antibodies: Globular proteins, immunoglobulins

4 polypeptide chains
- 2 heavy
- 2 light

Y shaped structure
- Tips contains 110 -130 amino acids for its specificity

- Variable region => Specificity for binding
- Constant region => Mechanisms for destructing antigen

5 classes
- IgM
- IgG
- IgA
- IgD
- IgE

Auto Immune Disease : In appropriate against owns immune response

Lupus	Juvenile rheumatoid arthritis	Scleroderma	Ankylosing Spondylytis	Juvenile Dermatomyositis
•Marked by •Muscle and joint pain •Inflammation •Attack on kidneys	•Attacks on (1)Joints (2)Knees (3)Hand (4)Foot	•Inflammation of skin, joints and internal organs	•Inflammation of spine, joints and internal organs	•Inflamation and damage of the skin and muscles

Allergies: Abnormal reactions to ordinary homeless substances.

Causes:

(1) Inhaling allergens like pollens, Latex, viruses, bacteria, dust,insect stings etc.
(2) Inherited genetically
  If neither parent is allergic => 15% chance
  If one parent is allergic => 30%
  If both parents are allergic => 60%
(3) Over production of Immunoglobulin E (I g E).
(4) Coats chemicals such as histamine which causes swelling and inflammation

Allergic conditions: Hay Fever, Asthama, eczema, hires and shocks

Treatment: Antiallergy drugs

Organ Transplant: Malfunction of any organ can be corrected by transplant.

→Receives immune respense due to mismatch of MHC proteins between donor and recipient.

→Therefore it receives a T-cell mediated rejection

Respiration

Control of breathing

- Involuntary Control
  Controlled by medulla oblongata
  - Ventral Portion
    - Increase Rate and depth of inspiration.
    - Inspiratory centre
  - Dorsal and Lateral Portion
    - Inhibit Inspiration
    - Stimulate inspiration
    - Expiratory center
- Voluntary Control →
  - Used in forced breathing, Speech, Singing Sneezing and coughing
  - Impulses orginate from the Cerebral Hemispheres and pass to the breathing center

Breathing center
- Intercoastal Muscles → Intercoastal Nerve
- Diaphargm → Phrenic Nerve

Features	Inspiration	Expiration
Other Name	Inhalation	Exhalation
Process	Active	Passive
Basic Mechanism	Passive expantion of Lungs	Passive contraction of lungs
Definition	Taking in of Air	Removal of air from Lungs outside body
Diapharm	Contracts, Moves down become less dome like	Relax, Moves up, become more dome like
Rib Muscles	Contract	Relax
Rib Cage	Moves Upward and Forward	Moves downward and inward
Volume of Thorax	Increases	Decreases
Pressure of Lungs	Decrease	Increases
Air Moves	Into Lungs	Out of Lungs

Mechanism of Transport

- Means Breath

Transport of oxygen in blood

⇒97 % Oxygen by RBC..... Oxyhaemoglobin
⇒3 % dissolved in plasma
⇒Haemoglobin....... 4 oxygen molecules
⇒At alveoli........RBC..... High partial Pressure...Oxygen bind
⇒Oxygen binding capacity
⇒Oxygen carrying capacity is directly proportional to partial pressure of oxygen
⇒Max 20ml/100ml of blood (100 % Saturated) at 100mm Hg partial pressure
⇒Haemoglobin 15g/100ml of blood
⇒1g Haemoglobin combine=1.34 ml oxygen
⇒Normal
- Arterial Blood → 19.4 ml/ 100 ml (97 % at 97 mmHg)
- Venous Blood → 14.4 ml/100ml (75 % at 40 mmHg)

⇒Exercise → Venous blood → 4.4 ml/100ml (20 % at 18 mmHg)
⇒Plasma
- **Arterial Blood:** 0.29ml oxygen/100ml of blood at 95mmHg and may increase upto 0.3ml oxygen/100ml f blood at 100mmHg
- **Venous Blood:** 0.12ml oxygen/100ml of blood at 40mmHg

⇒So plasma transport 0.17 ml by plasma

Transport of Carbon dioxide in blood

- ⇒70 % Bicarbonate ion
  ⇒Oxyhaemoglobion+H+........ HHb+4Oxygen molecules (Haemoglobinic acid)
  ⇒Haemocyanin (Molluscus)
  ⇒Haemoerythrin(Some marines)
  ⇒Chlorocruorin (Annelids)
- ⇒23 % Carboxyhaemoglobin
  ⇒ Globin part of Haemoglobin
- ⇒7 % as dissolved carbon dioxide in plasma

Respiratory pigment

Haemoglobin
(Metalloprotein)
Myoglobin
(Exchange by change in cytoplasm of muscle cell)

Pigments

- Oxyhaemoglobin
  - Haemoglobin → Blue
  - Chlorcruorin → Green
  - Haemoerythrin → Violet to pink
- Deoxyhaemoglobin
  - Haemoglobin → Colorless
  - Chlorcruorin → Colorless
  - Haemoerythrin → Colorless

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Respiration

Energy USE
- ⇒Food
  - Cellular Respiration
- ⇒ Aerobic Respiration
  - USE → oxygen
    - Air
    - Water
  - Release → Carbon dioxide
- ⇒Less Complex Organism
  - Direct from Air → oxygen
- ⇒Higher Animal
  - Special Surfaces
  - Gills +Lungs

Properties of Respiratory Surface
- •Physical process of diffusion
- •Permeable
- •Thin
- •Surface Area
- •Blood Supply
- •Steep Diffusion gradient

Human Respiratory System
- •Breath

Nose
- ⇒Only visible part (External)
- ⇒Structure
  - Bone
  - Cartilage
  - Fibro-fatty tissues
  - External feature Depends
    - •Ethmoid bone
    - •Cartilage
- ⇒Hair
  - Filtration of Air
  - Defense
    - Harmful Pathoge
    - Solid Particulate
- ⇒Mucous membrane
  - lined in
    - •Nostril
    - •Nasal Cavity
  - secrete Muscus + Cilia
    - •Air filter
    - •Enty of forign particle
    - Moistne the Air
  - Under
    - Blood Supply
    - Warm Air upto 30°C

Pharynx
- •Cone Shaped
  - Oral + Nasal Cavity
  - Oesophagus + larynx
- •Part of both digestive + respiratory system

Larynx
- •Dual function
  - •Air to Lungs
  - •Organ of voice
- •Composition
  - Cartilage (external)
  - Membran + Muscle fibre
- •Vocal cord
  - •Male larger
  - •Low pitch
- •Mucus membrane
  - •Horizontal

Trachea
- ⇒10-12 cm long
- ⇒2 cm wide
- ⇒16-20 Horse shoe Incomplete rings, in dense connective tissue
- ⇒Lined with ciliated Mucus membrane
- •Air
  - Moisture
  - Warm
  - Protection

Bronchi
- ⇒Two Bronchi
- ⇒Right
  - •Larger
  - •Shorter
- ⇒Small cartilage rings
- ⇒Air way Network

Bronchiole
- ⇒Terminate in Alveoli
- ⇒1 mm or Less
- ⇒Wall composition ciliated cuboidal epithelium + layer of smooth Muscles
- ⇒Can change diameter

Alveoli
- ⇒Gas exchange surface
- ⇒Wall is 0.1 micro meter thick
- ⇒Squamous epithelium
  - •thin
  - •Flatlened
- ⇒Collagen + elastic fibers
  - •Expand
  - •Recoil
- ⇒700 million Alveoli
  - 70 -90 m
- ⇒Surfactant
  - •Lower Surface
  - •Kill bacteria

Lungs
- Base on diaphragm Apex extend above the first rib
- •Located in thoracic cavity
- •Unequal in size
  - Right
    - ⇒56 % Air
    - ⇒3 lobes
      - Superior
      - Middle
      - Inferior
  - Left
    - ⇒2 lobes

Pleura
- •Two Membranes
- •Protect Lungs
- •Low friction

Lung volume and capacity
- •5 Liters Capacity
- •Tidal volume 500 ml → Exchange during one Breath
- •Residual volume 1.5 Liter → Remain in lungs

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Homeostasis

Introduction

- Envirnment
  - External
    - •Organism situation
    - •Varying Conditions
  - Internal
    - •Tissue lives
    - •Circulating organic liquid called Lymph or Plasma
- Homeostasis

Mechanism of Homeostasis

•Physical control system

- Components
  - Receptor(Sensor)
    - •Detects changes
  - Control system
    - •Integrates data from sensor and stored set point
  - Effector
    - •Effects on variable
- Feedback Mechanism
  - Negative Feedback
    - •Reversal of direction of change
    - •Decrease water–›Hypothalamus –›Posterior pitutary lobe –›ADH–› Collecting tubules–›Distal convulating tubules
  - Positive Feedback
    - •Amplify
    - •Baby's Head–›Uterus wall –›Birth
  - Harmful feedback mechanism
    - •High Fever–›Metabolic change –›More fever (113°F)
    - •Increase carbon dioxide in blood –›Faster Breathing

Osmoregulation

Water Ion concentration maintained in intra cellular fluid

- Water and solutes relation to the cells
  - •70% water in body
  - •Quantity vary cell to cell
  - •Medium of life –›Water
- Osmoregulation
  - •Different body and external environment solute conc.
  - •Regulate by energy
  - •Example: Land animals, most marine vertebrates
- Osmoconformers
  - •Body and external envinment have same solute conc.
  - •Example: Aquatic animals

Osmoregulation in animals of different environment

- Fresh water
  - •Almost all are osmoregulators.
  - •Passive movement of water in body.
  - •Loss of salts.
  - •Produce large volume of dilute urine+salts from food+active transport of salts from external dilute medium with special cell called **Ionocytes** (Present in amphibian's skin+Gills of fishes)
- Marine
  - Osmoconformer
    - • Cartilaginous fishes
    - • Examples: Sharks+ Rays+ Saktes + Some cyclostome like Myxine
  - Osmoregulator
    - • Bony fishes (Teleosts) are hypotonic to environment.
    - • Drink sea water result –›Excess Salts in body.
    - •Monovalent (K+,Na+, Cl-) removal across gill's epithelium
    - •Divalent (Mg++, Ca++)removal kidney
    - •Some fishes also have special salts secreting glands in walls of rectum–› rectal gland–›remove salt–›Digestive tract –›Egestion
- Terrestrail
  - Terrestrial
    - •Loss=water
    - •Adaptations:Chitaneous exoskeleton in arthropods and dead keratinized skin in vertebrates
    - •Anhydrobiosis: Metabolic and behavioral adaptations.
    - •Seed–›Breakdown–› water release (90%) e.g Kangroo rat.
    - •Examples: Invertebrate (Arthropods), Vertebrates (Reptiles, Birds. Mammals)

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Homeostasis

Excretion

- Carbon dioxide+water=Metabolism of Sugar, Lipis, Proteins
- Nitrogen wastes=Pretien+Nucleic acid
- Primary Nitrogen Waste=Ammonia

Features	Ammonia	Urea	Uric acid
Toxicity	Soluble toxic	100,000 time less toxic than ammonia	Less toxic than urea
Solubility	1g nitrogen in the form of Ammonia req 500 ml water	1g nitrogen in the form of urea req 50 ml water	1g nitrogen in the form of uric acid req 1 ml water
Condition	Ammonotelic	Urecotelic	Uricotelic
Examples	Fishes, Protozoa, Sponges, Colentrates, Echinodermers	Marine, terrestrial	Terrestrial Invertebrates, Egg laying vertebrates

Human Excretory system

- Skin, Lungs, Liver and kidney.

Kidney:
Dark, slightly flattened, bean shaped organs.
12cm long, 6cm wide, 4cm thick,150gm weight.
- Just below diaphargm between last thoracic vertebrae and third lumber vertebrae.
- Upper part of kidney partially protedted by the eleventh and twelfth ribs.
- Right kidney little lower.
- Outer convex inner concave shape.
- Hilus, Renal pertitonium.
- Cortex part (Renal corpuscles+convoluted tublues of nephrons)
- Medulla (Pyramids→Projects to pelvis →Ureter

Ureters: 28cm long, narrow, muscular, tubular structure, rise from hilus run backward along the dorsal body wall and open on the dorsal wall of urinary baldder.

Urinary Bladder: Pear shape sac, in pelvic region of abdominal cavity.
- Store: 0.5 to 1 Liter urine.
- Sphincters→ Relax→ Urine comes
- Micturition→Act of emptying the bladder.

Urethra: Neck of urinary bladder to exterior.
- Length: Females(2-3cm long only for urine)
  Males (20cm long for urine and spermatic fluid)
- Pinus→Urinogental aperture

Nephrone

Parts

Renal Corpuscle

Glomerulus
- Capillary Tuft
- Receive→Afferent Arterioles
- Help in Filtration

Bowman Capsule
- Cup shaped
- Enclosed glomerulus
- Podocytes
- Capillary Endothelium and gap in podocytes help in filtration
- Large particle protein molecules stopped by basement membrane of blood Capillary.

Renal tubules

PCT
- Longest part of nephron
- Lined by epithelial cells having brush boarder composed of microvilli (Surface area)

Loop of Henle
- U shaped
- Prominent in juxtamedullary nephron.

DCT
- Most distal part

Collecting ducts
- First part of collecting tubules

Types

Cortical nephron
- Renal Corpuscles in superficial Renalcortex
- Short loop of Henle
- 70%-80% of nephron
- In normal condition deal with control of blood volume

Juxtamedullary Nephron
- Renal corpuscles close to the junction of cortex and medulla
- Loop of Henle long
- 20% to 30 % of nephrons

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Homeostasis

Blood supply of Kidney
- Renal artery→Afferent arteriole→Efferent arterioles→Perotubular Capillaries
- Vasa recta →Run antiparalel

Excretory system of Nephron
Functions of nephrons: Filtration, Removal of Wastes, Urine formation

Ultrafiltration
- Efferent diameter half to the afferent →Cause of pressure
- 20% of plasma filtered into Bowman's capsule
- Filtrate has to cross endothelium of glomerulus capillary→basement membrane of capillary→endothelium of Bowman's capsule

Selective Reabsorption
- 125ml of glomerular filtrate/min
- 180 Liter of glomerular filtrate/day
- PCT→80% reabsorption, include Glucose, A.A, Vitamins, Hormones, and 80% NaCl and water.
- Ascending limb→Impermeable to water however permeable to Na+,Cl-,K+ and other ions reabsorbed actively.
- Descending limb→Highly permeable to water.
- Counter current mechanism
- DCT→Osmoregulatory role+pH control
- Collecting duct: Impermeable, ADH makes it permeable

Tubular Secretion
- Peritubular Capillaries to renal tubular lumen
- Active transport mainly H+,K+, Organic ions
- H+ Ion maintain acid base balance

Kidney as osmoregulatory organ

Control of water level
- Solute potential in blood is maintained by ADH
- Decrease water level → Hypothalamus →Detects fall in blood solute potential → Release ADH → ADH
- Increase the permeability of DCT and collecting duct to water →water reabsorbed (Concentrated urine)
- High intake of water → ADH relase is inhibited (Dilute urine)

Control of Blood sodium level
- Na+ level maintained by aldosterone
Aldosterone secreted by Adrenal cortex
Activates Na+/K+ pump in DCT
Na+ Pumped back to blood from filtrate actively

Urinary tract infection
- Ureter is rarely the site of infection

Classification
- Pyelonephritis (Kidney infection)
- Cystitis (Bladder Infection)
- Urethritis (Urethral Infection)

Causes
- Bacteria (Escherichia coli, Staphlococcus saprophyticus, Klebsiella, Enterococci, Proteus mirabilis)
- Fungus (Candida albican also attack on mouth, digestive system, vagina)

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Excretory system problem

Kidney Stones

Kidney stones are hard crystalline minerals

Symptoms
•Traveling from kidney to bladder cause pain only
•Pain appears at side belly or groin and color of urine becomes pinkish or reddish

Chemical nature of stone
• Ca++ in combination of oxalate and protein (70%)
• Uric acid (5-10%)
• Amino acid cystine (1-3%)
• Infection in urinary tract called struvite or infection stone (15-20%)

Causes
† Hypercalcemia
•Increase Ca++ in blood (Hypercalciuria)
• Hyperparathyrodism (Ca++ absorbed from food excreted in uria)
† Hyperoxaluria
• Over dose of tomato and leafy vegetables
†Hyperuricemia
•Increase uric acid
•Due to high intake of protein (Gout)•

Treatment
0.5cm can pass through kidney
1cm can not.
Procedure depends upon type and size of stone

Percutaneous Nephrolithotripsy	Extra corporeal Shock wave lithtripsy
Larger stone	Small stone
More commonly used	Sound waves

Old method
•Tube–›Patient back to kidney –›scope is run–›ultrasound waves send–›stone fragments grasped
•Used for larger complicated staghorn stones

Renal Failure/Kidney Failure

Acute kidney Failure
•Suddenly become unable to filter
•Develops rapidly in a few days

Cause:
•Blood clots
•Cholesterol deposit
•Chemotherapy
•Antibiotics
•Toxins (Alcohol,Heavy metals, cocain)

Chronic kidney Failure
•Gradual loss of kidney function
•Can progress to and-stage renal disease(ESRD) and uremia (Fatal)

Cause:
•Diabetes
•Hypertension
•Long term use of Anti-infalammatory drugs and other analgesic medicines

Treatment

Acute
•Dialysis
•Dietary modification

Chronic
•Medication to controlDiabetes, hypertension
•Progresses to ESRD, renal dislysis or kidney transplant

Renal dialysis

Procedure to filter toxins

Peritoneal Dialysis
Process:
•Two catheters–›Abdominal cavities –›One catheter gives diasylate–› Molecules of diasylate can not cross peritonium–›Diasylate attracts toxins–›Second catheter carries diasylate out of the body
•Exchange+Dwell

Advantage:
•Mobility
•Can be performed at home

Disadvantage:
•Success as compare to haemodialysis is variable because permeability varies human to human

Haemodialysis
Process:
•Use dialyzer
•One catheter in blood –›Dialyzer Membrane–›second in blood again

Advantage:
•Effective

Disadvantage:
•Infection with hepatitis
•Injury to blood vessels
•Microscopic damage to blood cells

Kidney Transplant

•Replacement of diseased or missing kidney
•Life of kidney with immunosupressive drugs is 5-10 years

Donor recipient Match
•Same Blood groups
•Must match human Leukocyte antigen (HLAs), Six HLAs are there, must match at least three
•Donor blood must not initiate and antibody reponse

Risk and complications
•Bleeding during or after operation
•Postoperative infection
•Transplanted kidney lower in abdomen so lack ribs protection and leads to traumatic injury
•Always risk of organ rejection

Prepared By
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Thermoregulation (Maintenance of body temperature)

Introduction

1. Temperature affects rate of enzyme activity
2. Rate of movement of atoms and molecules
3. Geographical distribution of animals

Classification of the base of body temperature

Poikilotherms	Homeotherms
Unable to maintain temp within narrow range	Able to maintain a fairly constant body temp
Invertebrates, Fishes, amphibians, and reptiles	Birds, Mammals

Classification of the base heat gaining sources

Endotherms	Ectotherms
Chemical reaction of ingested food	Heat from external environment
Great white shark, Flying insects, Birds, Polar bear	Reptiles, amphibians, fishes, and invertebrates

Thermoregulation in Humans

- 36.4 to 37.3 Degrees range of temp
- Thermogenesis: Heat production mechanism
- Tregulated by Nervous and Hornmonal System

Shivering Thermoregulation

- Stimulation of volentary muscles by motor neuron
- Increase heat production five times

Non-Shivering Thermoregulation

- Thyroxin increase heat production (Long term effect)
- Adrenaline increase heat production (Short term effect)

Heat Loss

- Radiation(50% of total heat loss)
- Convection
- Vasodilation
- Evaporation
- Evaporating through Lungs
- Regulate sweating

Heat Conservation

- Fatty layer in hypodermis
- Additional fat insulation of vital organs, Kidney,
- Heart.
- Vasoconstriction
- Hair Goose Bumps

Role of Hypothalamus

- Control the blood temperature
- Skin has receptors that send signals to Hypothalamus and Semsory area of cortex
- Vasodilation (Radiation, convection, conduction)
- Activation of sweat gland
- Decrease metabolic activity
- Vasoconstriction(Radiation, convection, conduction)
- Inhibit panting
- Increase metabolic activity (Shivering+Non-shivering mechanism)

Fever

Increase in core temperature in fever or pyrexia

Cause: Malaria + Typhoid

Mechanism:

Chemicals by neutrophils+Pathogens→Pyrogens→ Hypothalamus→Increase temperature set point→ Stimulate the defence response →Help to destroy pathogens

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Support & Movement

Introduction
- Support → Uphold the Body against Gravity
- Skeleton (Main support)

Human Skeleton

Cartilage
- Connective tissue (Soft) formed of chondrocytes
- Collagen type II
- Avascular, Aneural
- Slow healing
- Cartilage Replaced by Bone
- Types (hyaline, elastic, fibrous)

Bone
- Rigid connective tissue (living)
- Hand & strong
- Resist (blending & Compression)
- Ground substance & matrix
- 65% inorganic ($CaCO_3$, Ca_3PO_4)
- 35% organic (collagen)

Cells

Osteoblast
- Mononucleate
- Type I collagen
- Mineralization of matrix
- Entrapped in matrix to become osteocyte

Osteocyte
- Mature Bone cells
- Extension to meet osteoblast & osteocyte
- Maintain Bone ca++
- Regulate Bone Response to stress

Osteoclast
- Large, Multinucleated
- Remove Mineral matrix & Break organic Bone
- Bone resorphon
- Phagocytic like mechanism

Division of Skeleton
Birth – 350 Bones
Adult – 206 Bones

Axial
- Skull
- Spine
- Ribs

Appendicullar
- Pelvic & Pectoral girdle
- Upper & lower Limbs

Composition

Calcitonin & Parathormone

30% organic (90% collagen)

70% Inorganic (hydroxyaoatite, Ca_3Po_4, Mg, F, Cl, Hco_3)

Joints

Fibrous Joints
- Thin fibrous tissue hold bones
- No Joint cavity, immovable
- Protect & Support Body
- B/W skull bones, B/W sacrum & iliac Bone

Cartilaginous Joints
- Connected by hyaline or fibrocartilage
- No Joint Cavity
- Limited & gliding
- Cartilage → flexible connection
- B/W vertebra & wrist and ankle

Synovial joints
- Bone are separated by synovial cavity
- Freely movable
- Strengthen by ligament
- Ligament Position the Bone
- Structure determine the Movement

Hinge (one plane)
Cylindrical projection → trough surface of other flexion & extension, elbow & knee

Ball & Socket
(freely moving))
- one bone articulate with socket of another
- Hip & shuolder joints

Disorders of skeleton

Disc slip
- IV Disc → Shock absorber
- Herniation (Inner gel of disc escape to surrounding)
- Leaking jelly compress spine
- Herniated disc
- Any disc can rupture
- Common in lower back
- Injury, aging, loss of elasticity of dis, excessive strain, improper lifting

Spondylosis
- Spinal osteoarthiritis
- Loss of spinal function
- Aging (P.cause)
- Common in neck, mid back lumber

Sciatica
(Pain numbness in leg)
- Injury / pressure of of sciatic nerve
- Nerve (lower spine → leg back)
- Cause (Slipped Disc)
1. Pelvic Injury
2. Piriformis syndrome
3. Fracture
4. Tumor

Arthritis
- Inflammation of Joints
- Leading caus of disability
- Joint pain, swelling
- Stiffness, warmth feeding on Joint
- Skin Redness, inability to move
- Cause
1. Infection,
2. Autoimmune disease
3. Wear & tear

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Support & Movement

Skeleton

Distribution of bones in Human body

Main part	Subparts		Total bones
Skull	Cranium Ears Face	8 bones 6 bones 14 bones	28
Neck **Trunk**	Hyoid Vertebral column Chest bone Ribs	Bone 1 26 bones 1 24 bones	1 51
Limbs	Upper limbs Lower limb	64 62	126

Skull bones

Skull		Unpaired bones	Paired bones
Cranium	8 Bones	• Frontal • Occipital • Sphenoid • Ethmoid	• Parietal • Temporal
Facial bones (face)	14 bones	• Mandible • Vomer	• Mxilla • Zygomatic • Lacrimal • Nasal • Inferior concha • Palatine
Auditory ossicle (ear bones)	6 bones		• Malleus • Incus • Stapes

Axial Skeleton

Features	Skull	Vertebral Column	Ribs
Parts	• Cranium • Face	• Cervical • Thoracic • Lumbar • Pelvic	• True ribs • False ribs • Floating ribs
Bones	8+14+6=28 (Excluding hyoid bone	7+12+5+2=26	14+6+4=24
Functions	• Protection of brain • Attaches pelvic & pectoral girdle	Protection of vertebral column	Protection of internal soft organs such as heart, lungs etc

Appendicular Skeleton

Features	Pectoral Girdle	Forelimbs	Pelvic Girdle	Hind Limbs
Parts	----	2 • Upper arm • Lower arm	2 (Coxal bones)	4 • Thigh • Shank • Ankle • Foot
Bones Name	• Coracoid • Clavicle • Scapula	• Humerus • Radius • Ulna • Carpals (Wrist) • Metacarpals (Palm) • Phalanges (Fingers & Thumbs)	• Illium • Ischium • Pubis	• Femur • Tibia • Fibula • Tarsals (Ankle) • Metatarsals (Foot) • Phalanges (Fingers & Toes)
Functions	Clavicle connects sternum with scapula hence providing support to upper skeleton	Movement of skeleton	Supports lower skeleton, attaches vertebral column with lower limbs	Movement of skeleton

Support & Movement

Bone Fracture

Simple
(Closed)
•Skin intact

Compound
(Open)
•Bone penetrate skin+Wound

Repair of Fracture bone

Closed reduction
(External)
•Physician's Hand

Open reduction
(External)
•Physician's Hand

Steps to Heal Bone fracture

1.Heamatoma formation
2.Fibrocartilage callus formation
(Fibroblast→Secrete Collagen→Mature to catilage)
(Osteoblast role)
3.Bony callus formation
4.Bone remodeling

Joint Disorders

Joint Dislocation
•Joint Slip out of place
•Mause tearing of muscles, ligamnets and tendons
•Symptoms:ay c Swelling, Intense pain, Immobility
•Causes: Blow, Fall Trauma, Rheumatoid arthritis

Sprain
•Injury to ligament
•Treated with icing, Physical Therapy, Dressing, Bandages, Ace wrape

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Muscles(Mesodermal Origin)

Types of Muscles

Property	Smooth Muscles	Cardiac Muscles	Skeletal Muscles
Muscle appearance	Unstriped	Irregular striped	Regular striped
Cell shape	Spindle	Branched	Spindle or cylindrical
Number of nuclei	One per cell	Many per cell	Many per cell
Speed of contraction	Slow	Intermediate	Slow to rapid
Contraction caused by	Nervous system	Spontaneous	Nervous system
Function	Controls movement of substances through hollow organs	Pumps blood	Move skeleton
Voluntary control	Usually no control	Usually no control	Have control

Muscle problems

Features	Cramps	Muscle fatigue	Tetany
Definition	Sudden, involuntary contractions or spasms in one or more muscles	Muscle cannot produce maximum contraction. Also called contractures, states of continuous contraction	Characterized by muscle cramps, spasms or tremors
Causes	Nerves malfunction Straining or overusing a muscle Dehydration Lack of minerals in diet Depletion of minerals in body Not enough blood getting to muscles.	ATP decline Contractile proteins alteration intracellular accumulation of lactic acid Other ionic imbalances	Low levels of calcium
Areas Effected	Hips and thigh muscles	Mostly muscles of arms and legs	Face, fingers or calves

TETANUS

•Infection of the nervous system (Clostridium tetani).
•Spores of the bacteria C. Tetani can remain infectious for more than 40 years.
•The spores release bacteria that spread and make a poison called tetanospasmin.
•Poison blocks nerve signals from the spinal cord to the muscles, causing severe muscle spasms.
•The spasms can be so powerful that they tear the muscles or cause fractures of the spine.

Structure of Skeletal Muscles

Structure
•Attached to the skeleton.
•Consists of muscles bundle→muscles fibre→Myofibril

Muscle Fibre
•Cylindrical, unbranched , diameter of 10-100um.
•Semi fluid matrix,sarcoplasm or cytoplasm,
Multinuclei (Periphery)many mitochondria.
•Sarcolemma , the transverse tubule (Continuous extracellular fluid).
•T-tubule + Terminal portion of the adjacent envelope of sarcoplasmic reticulum = Triads
•Fibre red=Presence of the myoglobin
•Also have glycogen.

Myofibrils
•1-2um diameter
•Alternate light and dark bands, "striped" appearances.
Sarcomere (functional unit of the contraction process)
•Smaller contractile unit .
•Dark bands are A band (anisotropic).
•Light band are 1 band (isotropic).
•Each A band has a lighter strip called H-zone
(hele for called Z – line (zwish meaning between).
•A sarcomere is the region of a myofibril between two successive Z – line.

Myofilament
•Central thick filament(myosin) surrounded by thin filament(actin), linked together by cross bridge.
•It also has tropomysosin and troponin proteins.
•Thick filament has a tail terminating in two globular heads,

Muscles Contration

Sliding filament hypothesis
•Proposed by H. E. Huxely and A. F. Huxely.
•Muscle contracts
1.H zone disappears
2.I band shortens
3.Z lines come close to each other
4.A band remains same
•Release of calcium ions from the sarcoplasmic reticulum →reorientation of thin actin filaments.

RECOVERY: MUSCLE FIBRE RELAXATION
•Electrical impulses →Muscle fibre cease, the sarcoplasmic reticulum begins to re-accumulate the calcium ions by active transport.
•Ca++ sarcoplasmic reticulum sacs, which takes only milliseconds, the binding between the myosin heads and the actin filaments can no longer occur.
•As a result, the thick and thin filaments slide past one another, returning to their relaxed state of minimal overlap.

CONTROL OF MUSCLE CONTRACTION
•All-or-none phenomenon.

ENERGY OF MUSCLE CONTRACTION
(a)ADENOSINE TRIPHOSPHATE
(b)PHOSPHOCREATINE
•About 35% energy is utilized for the performance

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Nervous Co-ordination

Steps Involved in Nervous Co-ordination

- Composed of Neuron (Functions)
- Higher animals Compositions.

Reception of Stimulus

- Receive Information→ Part→Receptor/transducers
- Receptor = Cell + Organ + Neuron ending

Processing / Analysis of Information

- CNS = Co-ordinating center.
- Associative or Intermediate Neurons

Response to stimulus

- Response =Effector (muscle + Glands)
  ↓ Movement secretions

Classification of receptors

Base = Stimuli

Photoreceptors

- Detect light e.g rods & cons cells in retina

Chemoreceptors

- Chemical (Ion + Molecule)
- Nasal epithelium
  ↓ Smell (olfaction)
- Tongue
  ↓ Taste (Gustation)
- Hypothalamus (osmoreceptors)
  ↓ Change in osmotic pressure of blood

Mechanoreceptors

- Change in pressure, position, acceleration
- Touch (Meissner's (corpuscler in skin)
- Stretch/ pressure (Pacinian's corpuscles in skin & baroreceptor in blood vessels)
- Equilibrium
- Hearing

Thermoreceptor

- Detect temp
- In skin

Nociceptors

- Detect pain

Nervous Co-ordination

Neuron
- Structural and function unit
- More than 50% Nervous system=Neuroglial cells
- Neuron=Cell body+Fibrous structure (Dendrite+Axon)
- Dendrites= Increase cell surface Area + Non-myelinated Receptor to cell body, thin
- Soma = Single Nucleus + Many Mitochondia, microtubules, neurofibrils and Nissl's granule (group of ribosome +E.R and Golgi apparatus)
- Axon = Cell body to terminal endings, thick, More cytoplasm than dendrites, Myelinated
- Node of Ranvier = Non-mylinated part of axon b/w two schwann cells.
- Velocity of impulse in axon depends upon the diameter, length, myelin sheath.

Functions

Senrory
- Unipolar
- Receptor to CNS
- Dendrite end also act as receptor.
- Monopolar

Nociceptors
- Detect pain

Peripheral
- Receptor to dorsal root ganglia
- Long

Central
- Ganglia to spinal card or brain
- Short

Association
- Bipolar/Multipolar
- Brain+spinal cord
- Processing + interpretation of information
- Tree like appearance

Motor
- Multipolar
- CNS to effector
- Long Axon

Reflex Arc
- Pathway of Nerve Impulse
- Spontaneous, Involuntary, Unconscious
- Hand→Hot thing
- No involvement of brain

Receptor→Sensory Neuron→Spinal Cord →Motor→Effector

Nerve Impulse

Introduction
- Wave of electrochemical change that travels along the length of Neuron
- Normal condition=Inside (-Ve) Outside (+Ve)

Channels
- Pumps
  - Active
- Gates
  - Passive
  - Voltage Gated
  - Non-Volatge Gated

Resting membrane potential
- Outside +ve
- Inside -Ve
- Polarized state
- -70mV

Distribution and active movement of Na+ and K+ ions
- Inside 30 times greater K+
- Outside 10 times greater Na+
- Movement of Na+/K+ active (Na+/K+ Pump)
- 2K+ inside and 3 Na+ ouside

Negative organic ions
- A.A, Proteins, RNA, DNA

Leakage of K+ ions
- K+ Move out→K+ gates
- Inside more posotive

Active membrane potential
- Outside -ve
- Inside +Ve
- Depolarized state

Threshold stimulus
- Stimulus to bring an electrochemical change
- Subthreshold or inadequate stimulus Influx of Na+ ions
- Voltage regulated Na+ gates open
- -70mV→0→+50mV
- Reaction time=1msec
- Peak action potential=Spike potential
- Permeability of Na+ decreases and become more permeable for K+ (From cytoplasm to extracellular fluid due to K+ gates)
- Now Na+ gate closed

Refractory Period
- Recovery period
- Regain its original ionic distribution

Types of nerve impulse

Continuos impulse
- In nonmylinated
- K+ and Na+ move across the membrane

Saltatory impulse
- Mylinated
- K+ and Na+ can not move across the membrane.
- Ionic exchange only at node of Ranvier

Speed of nerve impulse
- Depends upon morphology of nerve fiber
- Average speed=100-120m/sec
- Mylinated → speed→20 times → Prevent loss of energy
- Diameter of fiber→Thick (faster) Thin(slow)
- Resistance to electrical flow is inversely proportional to cross section area of conductor

Synapse

Introduction

- Function between axon terminal of one neuron and the dendroid of another neuron
- No cytoplasmic connection

Types

Electrical Synapses

- Synaptic cleft (0.2mm)
- Current ➔ Pre to post Synaptic cleft

Chemical Synapses

- Majority
- Synaptic cleft (20mm)
- Chemical massager (Neurotransmitters)

Transmission of Nerve Impulse across synapse

- Synaptic Knob (Synaptic vesicle)
- Vesicle contain 10,000 neurotransmitters molecules
- Action potation ➔ Pre synaptic terminal → membrane Depolarize → Voltage gate open → ca++ diffuse to synaptic knob → cause → vessicle to close membrane → Release neurotransimitter → Diffuse out → Bind to synaptic membrane → Na+ ion channels open → Membrane depolarize → Excitatory post synaptic potential (EPSP)
- If k^+/Cl^- open then hyperpolarizer → Inhibitory post synaptic potential (IPSP)
- Acelycholine ➔ Acelycholinesterase
- Adrenalin ➔ Monoamine oxidase

Neurotransmitters

- More than 100 known
- Classes=Acetycholine, biogenic amine, amino acid, neuro peptides, gases.
- Excitatory = Acetycholine
- Inhibitory = Serotonin

Organization of Human Nervous system

- Centralized Nervous system
- Flatworm→Chordates
- Most advance

Divisions
- CNS:- coordinating center
- PNS:- Receptors, CNS effector link
- CNS:- Brain & cord
- Brain:- More Coordination
- Spinal cord:-Link brain and PNS

Protection
- Skeleton
- Craninm & v.column
- 33 vertebrae
- Prevent from trauma & accident
- Menings : system of membrane duramettter, pia matter arachnoid
- Provide cushion like matrix

- CSF:- From vessels of CNS by diffusion & pinocytosis between Pia malter & arachnid
- Protect from mechanical shocks, homeostasis of CNS
- Produced in Ventricle

CNS

Spinal cord
Central cable of CNS
- 18 inch long ½ inch dia. elongated, hollow front of Brain, taper posteriorly in urostyle inner grey matter, outer white matter. CSF in central canal cont. to Brain cavities,end blindly, covered with piamatter & arachnoid, space between these is filled by lymphatic fluid which protect from shocks
- Functon:- Reflex center
- S. Impuls=skin, muscle→Brain
- M. Impulses=Brain→Neck
- Take commend from brain

Brain
- Coordinate action
- Store information
- Modify behavior

Forebrain intergrating center

Thalamus
Relay between body and brain
Carry impulse to cerebrum

Hypotholamus
- Hormone production, hunger, thrust
- Fight/Flight, Sexual response.

Amygdale
Pleasure, Sexual arousal, Punish
Hippocampus
Long term memory & learning

Cerebrum
- Hemisphere joined by corpus callosum
- Carry memory to other side
- Control center of sight, speech,
- Smell, tastes, learning, memory thinking
- Reasoning, Judgment

Telencephalon
- Olfactory bulb cerebrum
- Olfactory bulb→smell
- Cerebrum→convulsion that relate to intelligence
- Cerebrum→largest portion

Diencephalon
- Limbic system
- Thalamus
- Hypothalamus
- Hippocampus
- Amygdala

Hind Brain
Pons-above medulla
- Conduct impulse between medulla, breathing, sleep, wakefulness,

Cerebellum
- 2nd largest part
- A central & 2 lateral lobes
- Guide accurate motion
- Coordinate muscle activity
- If destroyed movement →jerky shaky

Medulla
- Most posterior part of Brain continuous with spinal cord
- Communicate body & brain
- Heat beat, salivary secretions
- Swallowing, Vomiting
- Coughing, sneezing

Mid Brain
- Relay of visual & auditory information
- Recticulor formation (Mid brain, medulla) upto thalamus Hypothalamus
- Receive impulse from senses, send output to higher Brain center Filter sensory info

Organization of Human Nervous system

PNS
Sensory & Motor neuron
that may form ganglia & nerve

Ganglia
•Collection of cell bodies
Relay points between different
body parts such as CNS & DNS
may form complex system
(plexus)

Nerve
•Bundle of axon & dendute bounded
by membrane.
Receptor→CNS→effector
sensory (Receptor→CNS)
Motor (CNS→effetor)
Mixed(sensory+motor nerve)

Cranial
Cranial originate from brain,
12 pairs pass from foramen, supply
to peripheral tissue except vagus that
extend to abdomen
Sensory (1,2,8) Mixed(4,7,9,10)
Motor (3,5,6,11,12)

Spinal
Spinal→arise from spinal cord nerve
31(8 cervical, 12 thoracic 5 lumbar,
5 sacral, coccysgeall2)

Somatic
Carry info between CNS & voluntary
parts of body skeletal muscle, skin
info may be sensory, motor called
voluntary
Reflex are exceptions

Antonumic
•Sum between CNS (hypothalamus,
medulla) to internal organ e.g
heart, lungs, viscera,
smooth & cardiac muscle
Involuntary control

Sympathetic
Prepare for emergency opposite to PS
•Increase heart beat, B.P, glycogenolysis
•Dilate trachea, bronchi, pupil
•Inhibit Peristalsis, Bladder and rectum movement
•Shunt blood away from skin, viscera to brain
,heart muscles.

Parasympathetic
(state of rest)
•Slow heart beat & B.P
•Constrict Pupil
•Increased blood flow to skin
(Peristalsis of gut)
•Reverse of S.N.S

Structure and function of special receptor
**(Some scattered in skin+
Some are organs like ear, nose
tongue)**

Taste
(Ridge called papillae)
•Filliform (cone shaped
all over the tongue)
•Fungiform (mushroom
shaped, tip & side)
•Foliate (series of fold
at side of tongue)
•Ciramvallete (mound
surrounded by trench)
all have taste buds except
filliform
•Taste bud→ Taste cell

Smell
•Human not important
as other
•Olfactory mucosa in
nose, olfactory
transduction
•Receptor have cilia
which have olfactory
protein
•1000 types of
receptors

Touch
•Mehanoreceptor activation
of neural receptor in skin & hair
follicle
•Removal of hair
decrease touch
•Sensitivity also present in
tounge & throat
•Uneven distribution
•Finger & tongue→ 100/cm2
•Back of hand →10/cm2
•Tactile anasthesia, loss
of ability to feel any thing
•Parasthesia - tingling
numbers of skin, results
from damage to nerve
temporary or permanant

Pain
•Nerve fiber exposed
to extreme they signal pain
•Warning of danger
•Without pain
•No real zaton of danger
Types
•Cutaneous (skin)
•Somatic (Bones & joint)
•Visceral (Body organ)
•Also present deep in body
1 Cm_2 have 200 nociceptor
15-Pressure
6-Cold
1-Warmth

	Nicotine	Cannabis	Nicotine	Alcohol	Inhalants
Introduction	Heroin is an illegal, higher addictive drug. Processed from morphine a naturally Extracted from the seed pod of certain v arieties of poppy plants.	Marijuana(psychoactive drug) Hashish (concentrated resin-female cannabis plant)	Alkaloid-in tobacco leaves but also found in many other plants of family Salanaceae.	It is absorbed quickly into the blood from digestive tract after drinking.	Chemical vapors or gases that produce psychoactive (mind alerting) effects Volatile organic solvents, flue gases, nitrites, and anesthetic gases, which are commonly found in glue, paint thinner, gasoline, and nail polish remover.
Medical USE	Diamorphine, diacetylmorphine, Strong analgesic (subcutaneous, intramuscular, or intravenous route) Acute Pain Treatment Chronic Pain Treatment	Amelioration of nausea and vomiting Stimulation of hunger in chemotherapy and AIDS patients Lowered intraocular eye pressure General analgesic effect.	Treating the patients habitual of smoking. Stimulate acetylcholine, norepinephrine, epinephrine, serotonin, vasopressin, dopamine, and beta-endorphin. At higher dose, nicotine enhances the effect of serotonin and beta-endorphin activity **Uniqueness** Acts both as nerve stimulant and sedative/pain killer.	Stimulates the body Component of many medicines like cough syrups. Antiseptic nature	
Abuse / Misuse	Short term or long term\ **Short Term Effects** Warm flushing of the skin, dry mouth, depressed respiration, and suppression of pain, nausea, vomiting, severe itching, and spontaneous abortion. **Long Term Effects** Addiction. Infectious diseases, for example, HIV/AIDS and hepatitis B and C, collapsed veins, bacterial infections, and abscesses, infarction of heart lining and valves, and arthritis.	Anxiety Depression Suicidal thoughts Psychosis (Severe mental disorder in which contact with reality is lost or highly distorted).	Commercially in the form of a pesticide. 60mg of nicotine will kill an adult. **Nicotine Poisoning** Vomiting and nausea, headaches, difficult breathing and stomach pains. Smoker mothers, nicotine damages the placenta, increasing the likelihood of miscarriages, pre mature births and damages to the foetus.	Reduces levels of serotonin and dopamine and at as a depressant. Affects your reaction time and judgment of speed. Destroys certain vitamins and interferes with absorption in Gut. **Alcohol Addiction** Memory loss, damage (cirrhosis or hardening) of the liver Hallucinations Depression and anxiety	Instant "rush" and, like alcohol, cause euphoria (extreme feeling of happiness) followed by central nervous system depression. Loss of self-controlled, violent behavior, nauseas Vomiting, unconsciousness, giddiness, loss of appetite, and At higher doses, hallucinations, loss of motor skills, slurred speech, \ and heart palpitations.
Addition if any					

Features	Stroke	Meningitis	Brain tumor	Headache	Alzheimer's Disease
Introduction					
Sign and symptoms					
Causes and risk factors					
Treatment					

Chemical Coordination

Next Page No#2

Introduction
- Endocrine system coordinate most body cell.
- Hormonal system→Metabolism transport of substances by cell membrane, growth & secretion it is called as chemical coordination

table of hormones chature from R & T notes

Hormones
Gland produces secretion called as hormones

Exocrine
(outsides secrete)
- Duct for transfer of hormones liver, sweat & Tear & glands

Endocrine
(within to secrets)
- Ductless glands
- Produced by exocytosis
- Carried by blood to target

Endocrine system
(20 glands)

Anterior lobe
Master glands
(Produce tropic hormones)
(TSH, ACTH, FSH, LH)

Median lobe
MSH
Increased in pregnancy stimulate production & release of melanin from melanocytes in skin & hairs which darken skin color

Posterior lobe
ADH: Released when
- Salute increases due to water loss
- Enhance water reabsorption in kidney
- Increase blood volume.

Oxytocin: (childbirth) released during childbirth
- Stimullus: stretching of uterus & cervix low level of oxytocin
- Released in waves cause labour pain & contraction
- Suckling also release oxytocin & cause letdown reflex

GH/STH
- Growth & development of skeletal muscles
- Skeleton in childhood stimulate cell division & protein synthesis
- Deficiency→dwarfism short stature, low growth Brain & IQ are not effected
- Gignatism (over secretion during childhood, person become giant)
- Acromegaly:- overproduced in early age, Large hands

ACTH
- Regulated by CRF, act on adrenal cortex & stimulate secretion of androgens &
- Glucocortocoids

FSH
- Gonadotroph stimulated by GnRH
- Female→stimulate the matuaration of ovarian follicle & production of estrogen
- Males→sperm production & development of germinal epithelium

LH
- Controlled by GnlH
- Female→Target in ovary trigger ovulation, estrogen progesterone. luteinization rupture follicle→corpus luteum
- Males: called ICSH, promote testosterone production in intestinal cells of testes

TSH
- Stimulate by TRF from hypothalamus
- Regulate function of thyroid
- TSH is regulated by -Ve feedback of thyroxin on hypothalamus and pituitary

Prolaction
- Enlargement of mammary Glands, and prepare for lactation, inhibit menstrual cycle in lactating women

Chemical Coordination

Page No#2 → Next Page No#3

Thyroid

Located either side of trachea
Produce, T3, T4, calcitonin

T3,T4

- Secrcted by in fluence of TSH.
- level of thyroxin regulate secretion by negative feedback
- Promote basal metabolic rate enhance glucose breakdown & synthesis of lipids in liver
- Promote CNS & skeleton growth & gut movement
- Hyperthyroidism graves disease, Autoimimune disorder, abnormal antibodies that mimic TSH High m.rate, irregular heartbeat nervousness, sweating & high body temp. weight loss despite of enough food, exophthalmic goiter , swelling of tissue around eyes & within orbit.

Hypothyroidism (lack of TSH) I deficiency in food, failure of enzyme in thyroxin production Major cause(loss in water & food) absence of I2 pituitary detect change & secrete more TSH & it stimulate thyroid to work &cause to enlarge, cause goiter, Iodized salt can reduce its chances.

Cretinism→Congenital deficiency mental retardation, poor physical growth, disproportionate body, delayed bone maturation & infertility

Adults→myxedema more weight due to accumulation of semi fluid meterial in skin low metabolism, chills, puffy eyes, thick & dry skin, hair lost from calp, edema, constipation, lethargy sluggishness, may result from I2 deficiency, thyroid enlarge & protrude called endemic goiter

Calcitonin

- Control extracellular
- Ca+ level, when it rise it transfer ca++ from (Blood→Bone) ,when level normal its production is decreased
- Inhibit ca++ absorption from small intestine & reabsoiption from kidney (ca+, K+ both)
- Imp in childhood when skelecton grow & bone change quickly if deficient →less ca++ on bones & high in blood may lead to kidney stone & effect muscle & CNS.

Parathyroid (4)

Located in Thyroid small, light colored lump on ventral surface of Thyroid

- Control calcium
- Release when ca+ is low in blood
- Stimulate osteoblast to reabsorb bone mineral & free
- Stimulate absorption of ca from intestines & reabsorption from kidney
- Over section is due to tumor more ca++ is released from bone

Bones ict soft, fracture easily high ca in blood canse depressed CNS & muscle weakness & kidney stone may formed undersection→ hypocalcemid increase excitability of neuron canse tetany, if untreated may fatal

Pancrease

Both endocrine & exocrine
Acinercell→Pancreatic Juice which go in duodenum & do digestion
Endocrine→islets of langshans (1 million)

σ cell→glucagone
B-cell→Insulin
Insulin→ produced when glucose rise
Reduce Glucose by

- Increases glucose uptake by muscle & fat cell & Glycogenosis
- Increase glucose in respiration & conversion of glucose to fats & protein synthesis, inhibit gluconeogenisis

Less insulin cause hyperglycemia ,kidney cannot reabsorb such high glucose and begin to secrete in urine (glycosuria) diabetes mellitus
Polyuria→ large amount of urine
Polydipsia→ more thrust
Polyphagia→ more hunger
Low glucose cause breakdown of muscle, Loss weight & tirdness untreated diabetes, cause disruption of heart & 02 transport, depression come, death
Hypersecretion→hypoglycemia hynger sweating, double vision, death
Glucagon:- Hyperglycemia agent released when glucose is low by & cell sympathetic system also effect it suppressed by somatostatin
Insulin & blood glucose (high)
Promote glycogenolysis & glucogenolysis (glucose synthesis from fats, protein) promote release glucose to blood by liver

Steroid hormones	Amino acid (Tyrosine Derived)	Proteins	Polypeptides
Cortical hormones • Cortisol • Aldosterone	**Thyroid hormones** • Thyroxin • Triiodothyronin	• Prolactin • Somatotropin	**Smaller polypeptides** • Vasopressin • Oxytocin
Ovarian hormones & Placental hormones • Estrogen • Progesterone	**Medullar hormones** • Epinephrine • Norepinephrine		**Larger polypeptides** • Insulin • Glucagon • Parathormone
Testicular hormones • Testosterone			

Chemical Coordination

Page No#3

Adrenals

Two adrenals on kidney cortex (outer), medulla (inner) cortex→ corticosteroid aldosterone→during low B.P Na+ or high K+, increase Na+ by acting on kidney, increase Na+ water reaborption stimulated by ACTH

Medulla→have ganglion neuron that produce epinephrinc & norepinaphrine have same effect.

epinephrine→metabolism broncho dilation, increase blood low to muscle, heart

Norepinephrine→PNS & stimulate B.P & vasoconstriction used as heart stimulent & to dilate Bronchiole in asthma attack

Gonades

Testes

- In scrotum
- Produce sperm & Hormones testosterone initiate maturation of male reproductive system, secondary sex characters & sex drive
- Required for sperm production & organ is their functional state

Ovaries

ova & Hormones

Estrogen: Maturation of reproduction organ & secondary sex characters at puberty

With progesterone promote breast & change in uterine mucosa in menstrual cycle.

Progesterone: thickening & vascularization of uterus for zygote implantation,maintain pregnancy & breast development

Feedback Mechanism

Type of interaction in which a controlling mechanism is controlled itself by product of that reaction

Positive

- Amplify change
- Destabilizing change
- No homeostasis less common

Negative

- Maintain homoeostasis
- Stabilize system

THE END

Behavior

Nature of Behavior

- **Behavior and stimuli**
  - Plant stimuli→light
  - •Territory
  - •Courtship
  - •Mating
- **Effects of genetics on Behavior**
  - Francis Galton
- **Biological rhythms**

Intrinsic / Innate Behavior

Programmed behavior (ethogram)

- •Honey bees
- •Duck swimming
- •Spider→web
- •Caterpillar→Cocoon
- •Bird→Nest
  →Migration
- •Removing hand from hot things
- •Acid stimulated leg of frog
- •Suckling

Simple

Complex ←

Characters

(1) Heritable
(2) Intrinsic
(3) Stereotypic (Same way)
(4) Inflexible
(5) Consumate (expressed at first performance)

Reflexes

- •Reflex arc, knee jerk(patellor jerk), coughing, Yawning, blinking of eyes, sneezing, salivation movement of diaphragm
- •Insect → starter, → escape

Orientation

→Co-ordinated movement

- **Kineis**
  - Sped of movement
  - Speed of movement directly proportional to intensity of stimuli (Orthokinesis)
- **Taxis**
  - Direction
  - Toward or away from source

Tropic movement

- •Geotropism
  Root and stem
- •Phototropism
  stem and root

Learning Behavior

Persistant change in behavior

(1) Non-heritable
(2) Extrinsic
(3) Permutable
(4) Adaptive
(5) Progressive

Type

- **Habituation**
  - •After exposure stop responding
  - •Lack of cont. responses to strong adoure
- **Imprinting**
  - •Innate + learning
  - •Critical period
  - •Konard Lorentz 1930
  - •Greylag geese
- **Classical condition (Typ-I)**
  - •Pavlov
  - •Dog ↓ Bell
- **Intrumental Learning (Operant learning)**
  - •Rewarding
  - •Cockroach ↓ moist
  - •Skinner ↓ Shapping (rats)

Insight learning

→Insight leaning→Judgment
•Kohlar
•Champnzea→Bananna
•Not trail and error

Social Behavior

Set of Interactions among individual of same species → Asocial (Mosquitoes,Polar bear)
Social (Packs of wolves, School of fish),ants, bees, termite, wasp)

Hostile and helpful intraspecific Interaction
- Division of laboor
- Sterotype pattern of behavior
- Ants, termites, bees

Aggression
- Threat, posture, rituals, physical attack
- Usually Same sex→specific
- Displacement of other animals from an area
- Agonistic (same species)
  ↓
  Same source

Territorial behavior
- Same or different species
- Prior to breeding→Male
- Spider Monkey→15-25 Animal
  ↓
  2-8 Animal group
  ↓
  Food
- Do not physical contact

Dominance hierarchies
- Hierarchy setted
  - Aggression associated with
    (1) Feeding
    (2) Mate selection
    (3) Breading site
- Avoid Injury to strong Animals
- Resources shared

Altruistic behavior

- Caring for other
- Itself disadvantage other advantage
- Female baboon→6 years protection to child
- Most birds
- Honey bee, wasp, ants, Monkey

REPRODUCTION

Introduction
- Survival value
- Transmission of one generation to other
- Essential to continue the survival

Human reproductive system
- Most efficient system
- Embryo→Female body birth.

MALE REPRODUCTIVE SYSTEM

Testes
- Pair in Scrotum
- 250-300 lobule
- Lobule have Seminiferous tubule here sperm produced
- Leyden cell produce testosterone

Vasa efferentia
- 10-20 vasa efferentia collect
- Sperm from testes

Epidermis
- Coiled at back side of testes
- Highly coiled
- 6m when uncoiled
- Transport & storage of sperm
- Sperm able to swin here

Vas deferens
- Start from epidermis & move deep in pelvis & join with duct of seminal vesicle to form ejaculatory duct that enter in prostate & then empty is urethra.

Urethra
- Terminal portion of male duct
- Open outside at external oriface and convey semen & urine

ACCESSORY GLANDS

Seminal vesicle
- Alkaline
- Fructose
- Vesiculase
- Vitamin C
- Increase sperm motility & fertilization power

Prostate
- Below Bladder
- Milky, Acidic
- Citrate
- Hyaluronidase

Cowper gland
- Mucus & alkaline fluid
- Neutralize acidity of urine in urethra
- Thick & clear mucus some drain in urethra when acids & urine

Semen: unite & sticky sperm+gland secretion mtritiunt protection & Transpose medium for sperm. Prostagland in decrease viscosity of mucus & wording curses aid slemn movment PH7.2-7.6 that help neutral, i.e tno Acid environment of vagina & urethra 2-5ne semen per ejaculation & have 20-150 million sperms

SPERMATOGENESIS
- Process of sperm formation have specific events, takes place in saminiferous tubule
- Spermatogonia outermost cell form epithelial wall of somniferous tubule. Just beneath basal lamina.
- Spermatogonia divide by the mitosis & form type A & B cells.
- A cell mentain germ cell line
- B cell→human, produce sperm

B cell
↓
P.Spermatoyte
↓
Secondary speimatoryte (meiosis I)
↓
Spermatid (meiosis II)
↓
Spermatid (Spermatogenesis)
Sperm→(Mature, elongate)

SPERM
- n cell
- Head, neck, mid-piece tail
- Head→Nucleus, chromosome
- Top of head →Acrosome that have hyaluronidase that help sperm to penetrate egg
- Neck→short & have pair of centriole one centriole elongate in whole length of tail
- Middle piece→mitochondria in axial filament
- Healthy male→400 million sperm per day.
- Process start at 14 year of age, continue until death

HORMONAL CONTROL

Hypothalamus
↓
Anterior Pituitary

FSH
Stimulate sertoli cells to complete sperm development

LH
Stimulate leyding cell to release testosterone that cause growth it germinal epithelium

Inhibin: by sertoli cells & control spermatogenesis
inhibin ∝ sperm
count is inhibit FSH & GnlH.

REPRODUCTION

Female Reproductive System

Ovaries
- Produce ova & Hormone
- Flank uterus on each ovary.
- Held in place in abdomen by ligament
- Almond shape
- 3-5 cm wide
- Have ovarian follicle that have immature egg called Oocye
- Ovulation
- Corpus luteum

Fallopian tube
- Initial part of duct system
- Receive ovulated oocyte
- Where fertilization done
- 10cm long extend near ovary & empty in Uterus
- Uterine tube → smooth.
- Muscle & Ciliated and non-ciliated cells
- Oocyte → uterus by beating cilia & peristalsis
- Non ciliated cells
- Produce Secretion for nourishment and moisture.

Uterus
- Pelvis,anterior to rectum, posterior to bladder,
- Inverted pear
- Hollow thick walked muscular organ, Receive, retain, nourish ovum.
- Perimetrium (onter most)
- Myometrium (middle, muscular, bundle of smooth muscle contract to help child birth)
- Endometrium (inner spongy lining of uterine cavity)

If fertilization occur embryo take root into endometrium and reside there

Cervix
- Entrance of uterus from vagina,
- Blocked by plug of mucus.

Vagina
- Thin walled 8-10cm long tube extend from cervix to exterior
- Copulation birth canal,
- Passage of delivery of in infant & Menstrual flow.
- Urethra is embedded in anterior wall.

Oogenesis
- Formation of egg, Years to complete
- Fetal period, oogonia(2n) multiply & enter in growth then transformed to P. oocyte & surrounded by single layer of follicle but stalled in prophase I & not complete at & remain suspended till 10-14 year of age

At puberty many oocytes are recruited & one in selected to continue meiosis I producing two haploid cells, one is secondary oocyte & other is polar body (n). Secondary oocyte is arrested in metaphase II till it is ovulated if sperm is absent it is destroyed if sperm present it produce Ovum & 2nd polar body, equal cytoplasm to ensure nutrient supply to egg for 6-7 day journey, other cytoplasm die.

Mental cycle
- Begin at puberty
- Oocyte change in & ovary, controlled by
- Anterior pituitary

Menstural phase (1-5 days)
- Uterus shed all but deepest part of endometrium it detach form uterus wall & shed off
- Bleeding (3-5 days) as menial flow
- At start of this stage ovarian hormone at lowest stage,
- Gonadotrophin are beginning to rise, FSH begin to rise

Proliferative phase (6-14 days)
- Estrogen rise endometrium grow & become velvety, thick & vascularized.
- Mucus is thick & sticky it become thin and crystalline forming chanal that aid sperm entry.
- Ovulation take less then 5 mints at end of
- Proliferative phase
- LH Response
- LH→Corpus luteum

Secretory Phase (15-28 days)
Endometrium prepare for implantation, progesterone rise from corpus luteum, that cause arteries to elaborate & form a glandular secretion. Uterina gland enlarge coil & secreteglycogenin uterus that sustain embryo in implantation. If no fertilization→LH decline &corpus luteum degenerate. progesteron fall→ endometrium cell die Mentualation end at age of 50 (metafile)

REPRODUCTION

DISORDERS

Female infertility
- Inability to be pregnant
- Blocked fallopian tube due to defect of inflammatory disease, endometriosis.
- Physical problem with uterus.
- Uterine fibroid, muscles on wall of uterus.

Male infertility
- By vericocele.
- Veins on testes are two large, heat testes that effect shapes, number of sperms
- Abnormal shape of sperm
- Injuries, inborn problems
- Cystic fibrous
- Few or no sperm

Pregnancy is resulted when
- Women release egg. (Ovulation)
- Egg go to fallopian tube.
- Sperm join with egg. (fertilization)
- Egg must attach to uterus. (Implantation)

IVF

Fertilization outside the body
Assisted Reproduction
used when sperms are too few or fallopian tube is blocked
- Multiple eggs are produced, then Removed from women & treated with sperm
- After 3-5 days embryo is implanted in female uterus.

MISCARRIAGE
- Loss of Pregnancy before 20th week of pregnancy.
- After 20th week called preterm birth
- Caused by chromosomal problem related to parents chromosomal drugs, Alcohol, toxin, obesity smoking, diabetes, immune reactionds
- Half of egg die before being viable state, Mostly 15-20% 7th week of pregnancy.

Abortion:-termination of pregnancy from uterus before it is viable
- Occur spontaneously, purposely induced, also called induced abortion of pregnancy.

STD'S

Gonorrhea
- Causative agent Neisseria gonorrhoeae. that invade the mucosa of repro+Urinary tract.
- Symptoms: Urethritis, None (20% of cases) to abdominal discomfort, vaginal discharge, abnormal uterine bleeding, urethral symptoms (similar like males)
- Untreated: In male urethral constriction+Inflamamtion of male duct. In female Pelvic infertility disease, sterility.
- Treatment: Penicillin,Tetracyclin, certain other antibiotics.

Syphilis
- Treponema pallidum, mother to fetus, fetus may Stillborn or die After birth,
- Bacteria Penetrate mucasa & aborded skin few hours of exposure→ red, painless chance at site, Small at Penis (male or) vagina or cervix chance→crusty heal in few weeks.
- If untreated pink skin spread at over body fever, Joint pair latent→ gummas,leison of CNS, bones, blood vessels
- Treatment by penicillin.

AIDS
- First case in San Francisco, New York, 20 years ago
- 3m death each year,
- Caused by HIV that attack on Cd_4
- Spread by blood,senor, breast milk, vaginal fluid changing needle, immoral sexual behavior, tattoing people having STD have move chance of AIDS
- Pregnant women→breast milk.

Inheritance

Introduction
Heridity→tendency of organism to resemble their parents
Variation→differences from parents
Genetics→ deal with variations & heredity gene.

Mendels's laws of inheritance
•Genetics originated: 1900
•Rediscovery by Augustinian Monk Gregor John Mendel in 1866.

GREGOR JOHN MENDEL & HIS WORK
•Mendel(1822-1884)→ classical geneticists. "Father of genetics."
•Born on July 22, 1822 in Czech Republic.
•Investigated variation, heredity and evolution in plants.
•1856-1863, 28,000, seven pairs of seed and plants
•Deliver first lecture 1865
•Paper 'Experiments on plants hybridization' in the year 1866.
•1900 work recognized by three investigators,
(1)Dutch botanist Hugo de Varies,
(2)De Correns of Germany and
(3)Tschmarck of Austria.
•He died in Brunn on January 6, 1884.

WHY NEGLECTED MENDEL
•Preoccupied with Darwin's theory of evolution which appeared in the year 1859.
•Journal was not recognized.
•Not familiar with the statistical analysis of experimental data.

MENDEL'S EXPERIMENT
Selected the garden pea (Pisum sativum)
•Easy growing in pots or in open ground.
•Short life cycle.
•Self-pollinating flowers.
•Cross-pollination was also possible.
•Distinct contrasting heritable characters.

INHERITANCE OF SINGLE TRAIT
Monohybrid cross
•B/w two individuals differ with one particular trait is called monohybrid cross."
First parental generation (P1)
(1)Round seed shape
(2)Wrinkled seed shape
First filial generation(F1)
Generation resulting from cross between first parental generation is called first filial generation."
Round seed shape as dominant trait.
F1 generation to be self-fertilized.
F2 generation both the parental characters appeared.
Dominant character
Character of F1
Recessive character
Hidden, appearance in F2
Mendel's Prediction
•Cytology was in its primitive state during Mendel's time.
•Factors or elements,
•Named as genes by Johannsen in 1909.
•Mendel, each male and female parent a pair of factors and each parent passed only one factor retained its individuality from generation to generation.
•Factors united randomly to produce the characters of the hybrid.
•He indirectly predicted the reduction in chromosome number during gametogenesis and the physical hereditary mechanism.

Inheritance

MENDEL'S PRINCIPLES OF INHERITANCE

Did not publish any law
(1) Law of dominance
(2) Law of segregation
(3) Law of independent assortment

Symbols used to represent mendel's laws

Dominant allele is represented by the capital letter
Recessive allele by the small letter.

Wild phenotype

"When out of two phenotypes, one is more common in the population that is alternative form; it is referred to as the wild phenotype."

"+" → normal allele for wild type

Mutant phenotype

"The rare form is called the mutant phenotype."

Base letter → mutant type.

Law of dominance

"Different characters are controlled by units called factors; factors occur in pairs, of a pair, one factor dominates the other."

Law of segregation

"The alleles separate or segregate form each other during gametogenesis, so that each gamete receives only one allele, either dominant or recessive."

Phenotypic ratio: 3:1
Genotypic ratio: 1:2:1

INHERITANCE OF TWO TRAITS

"A dihybrid cross describes a mating experiment between two organisms that are particularly different for two traits."

F2 → 9:3:3:1

Conclusion

Pairs of traits in the parental generation assorted independently from one another, from one generation to the next.

LAW OF INDEPENDENT ASSORTMENT

"It states that two pairs of contrasting traits when followed in a cross, the alleles of one pair assort independently with the alleles of other pair."

Experiment detail

SCOPE OF INDEPENDENT ASSORTMENT IN VARIATION

Recombination

"Recombination occurs during meiosis and is a process that breaks and recombines pieces of DNA to produce new combinations of genes."

STATISTICS AND PROBABILITY RELEVANT TO GENETICS

(1) Product rule

"Rule of multiplication is that the probability that independent events will occur simultaneously is the product of their individual probabilities."

(2) Sum rule

"Rule of addition is that the probability of an event that can occur in two or more independent ways is the sum of the separate probabilities of the different ways."

THE STATISTICAL NATURE OF INHERITANCE

- ¼ chance that the plant will have white followers.
- Among a large sample of F2 plants, approximately 25% will have white followers.
- The larger the sample size, the more likely it will be that the percentage of the results will approximate the prediction.

STATISTICS AND PROBABILITY

"Probability (p) is the chance that an event will occur."

Inheritance

EXCEPTIONS TO MENDELIAN INHERITANCE

Mendel →complete dominance

Complete dominance
When one allele (R) completely dominates the other (r) in heterozygous state is called complete dominance.
Heterozygotes (Rr) phenotype as the homozygotes (RR) have.
Example:
Seven characters chosen by Mendel

Incomplete dominance
Neither of the two alleles expresses independently in heterozygous state, blend of express of both alleles.
WORK OF CARL CORRENS
1899 4 O'clock.
EXPERIMENT
True breeding red flowered plant
+True breeding white flowered
is the same as the genotypic ratio.

Co-dominance
Not an intermediate quantitative expression , different alleles of a gene that are both expressed in a heterozygote condition.
Example,
AB both antigen A and antigen B

Over dominance
Phenotypic expression of heterozygotes (w/w) become more intense than the homozygous (w/w) state of the dominant allele, is called over dominance.
Example:
In fruit fly (Drosophila) the heterozygote (w+/w) has more quantity of florescent pigments in eyes than wild (w+/w+) or white eye (w/w) homozygote.

ABO BLOOD GROUP SYSTEMS

ABO Blood Type	Antigen (A or B)	Antibodies (Anti-A or Anti-B)	Donors
A	A	Anti-B	A, O
B	B	Anti-A	B, O
AB	Both A & B	None	A, B, AB, O
O	None	Both Anti-A or Anti-B	Only O

Blood Groups	Genotype
Blood group A	I^AI^A (Homozygous), I^Ai (Heterozygous)
Blood group B	I^BI^B (Homozygous), I^Bi (Heterozygous)
Blood group AB	I^AI^B (Heterozygous)
Blood group O	ii (Homozygous)

Inheritance

- **Rh SYSTEM**
- **MECHANISM OF ERYTHROBLASTOSIS FOETALIS**
- **GENE INTERACTIONS**
  - **Epistasis**
  - **Bombay Phenotype**
  - **Polygenic inheritance**
    - **Human skin color**
    - **Wheat grain color**
- **Gene linkage & crossing over**
  - **Gene Linkage**
    - •Genes on same chromosomes are called linked genes stay togather called as gene linkage
    - •X-linkage→Gene linkage it X-chromosome
    - •Linkage group→all linkage genes present at same chromosomes. lukemia, anaemia, Albinism at chromosome 11.
    - •Do not show recombination dependent assortment ratio is deviated
    - **Detection**
  - **Crossing over**
    - •Produce Recombination
    - •During prophase I
    - •New variation
  - **Recombinant Frequency & Genetic Map**
    - •Alfered H.Sturtevant
    - •Recombinant frequency depend upon distance between linked genes
    - •More distance→more chance of recombination & crossing over

$$\% = \frac{\text{sum of recombinant}}{\text{all recombination}} \times 100$$

e.g

b = color

vg = wing size

cn = cinnabar

cn - b = 9%

cn - vg = 9.5%

b - vg = 17%

Inheritance

Sex determination

XO-XX
XO-male
XX=female
•Nullo gametic
•Bugs & grassboppe
•Male determine sex

XY-XX
XY=male
XX-female
•Male determine sex
•Human & drosophila

Drosophila
X: A balance
1 = female
<1 = male

XX-XY or WZ-ZZ
XY=WZ=Female
XX=ZZ=Male
•Female determine sex
•Birds, butter fly and moth

Sex linkage

Sex linkage in drosophila

First Step cross
P1→F1

Second Step cross
F1×F1=F2

Test cross
P1 white eye male
×F1

Reciprocal cross
P1 white eye female
×Red eyed male

Sex linkage in Humans

X-Linked

X-Linked recessive
Hemophilia
Color Blindness
Diabetes Incipidus

X-Linked Dominant
Alport's Syndrome
Coffin-Lowry Syndrome
Idiopathic hypoparathyroidism
Vitamin D resistant rickets

Y-Linked

Holandric inheritance.
SRY genes

Sex related traits

Sex limited traits
•Confined to one sex only
•Anatomical differences
Example:
•Genes of milk in dairy cattle.
•Beared growth in humans.

Sex influenced traits
•Both genders
Example
•Baldness
(Autosomal dominant in man
and recessive in female)

Chromosome & DNA

Next Page # 2

Chromosome
- Thread like bodies
- Chromatin during interphase
- 1882.W.fleming waldayer→ proposed name (chromosome) colored bodies.
- Prokaryotes→Single DNA molecules is called as chromosome.

Number of chromosome
- Vary in species
- Two set→Diploid

More than 2→polyploid
Haploid→half of somatic
Haploid may be mono,Dip
- Fern→500 pair
- Penicillin→one pair

Structure:-
Chromatid, centromere secondary constriction stelellite, Junk DNA
- Telomere
- Metacentric (centromere at center)
- Telocentric (at end)
- Submetacentric (away from center)
- Acrocentric (near end)

Composition of chromosome
- 40% DNA
- 60% Protein
- 5cm long, 140 Nucleotide -ve charge by phosphate
- Strong affinity for +ve histone (H_1, H_2A H_2B,H_3, H_4)
- S-Phase→DNA and histone disorganized & DNA replicated & organized again.
- 10mm→Nucleosome string

↓
- 30nm (solenoid) G_1,G_2 Phase

↓

200nm Supercoiling

↓

700nm→again coiling
Euchromatin (expressed)
Heterochromatin (Condersed always & not expressed)

Gene

Background
Darwin→Pangenesis gemmules in gonads are transmitted to offspring,related by Galton through experiment
- Devries→Pengene (not migrate)
- Mendel→Unit of inheritance
- Johansson→ Introduce gene
- W.Batson→coined genetics for evolution, variation heredity

Modern Concept
- Mendel→elementen of factors now called genes,

Now gene is specific sequence of DNA that encode specific sequence of amino acid

Where gene seside
- On chromosome
- Allele (Alternate form)

e.g
$I \rightarrow I^A, I^B, i$ on Chromosome 9

Structure of Gene
- Promoter→5′, regulatory area control binding of mRNA
- Terminate or−3′, stop transcription
- Structural Region between promoter & terminator that code polypeptide
- Eukaryote -exon(functional) entron (non functional)
- Prokaryote no exon & intron, Regulated by same area called operon

Chromosome theory of inheritance
- Genes→unit of in heritance, chromosomes as carrier of heredity
- Karl correns→Rediscovery of Mendel work 1900 but no supportive idea
- Walter Sutton & Theodor Boveri→ Behavior of mendal factor is parallel to chromosome

Sperm→less cytoplasm & only contribute on Nucleus, unit must reside in nucleus
- Linkage discovered by T.H.Morgan (1910)

Parallel Behavior of gene & chromosome
- Both segregate during Meiosis
- Both assort independently of any other pair during anaphase
- Diploid cell gave two copies of both gene & chromosomes

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Chromosome & DNA

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DNA as a heredity Material

Chromosome→DNA+Pretein, which is involved in inheritance

- **Griffith Experiment**
- **Avery Experiment**
- **Chase Experiment**

DNA Replication

Self synthesis of DNA occur in S-phase parent DNA form two daughter DNA

Models

Semi conservative
- Watson & Crick
- DNA unzipped
- New DNA is mixture of Parent & doughtier DNA hybrid

Conservative
- Doughtier DNA formed
- Parental DNA is conserved
- Parent DNA remain intact

Dispersive
- Parental DNA is dispersed
- New DNA is mixture of old & new pregnant

Meselson experiment
- M.Meselson & F.Stahl in 1958
- Semi conservative Model confirmation

Process
- Bacteria→$\overset{15}{N}$ medium then transferred to $\overset{14}{N}$ medium
- Sample were taken at 0, 20, 40 mins
- Sample were centrifuged at High speed using $cscl_2$.
- 0min→heaviest→bottom
- 20min→between 0min & control
- 40min→one at top & other at intermediate level

Results
- 0 min→both→$\overset{15}{N}$
- 20 min→both→1$\overset{14}{N}$& 1$\overset{15}{N}$
- 40 min→$\overset{14}{N}$&$\overset{14}{N}$, $\overset{14}{N}$&$\overset{15}{N}$

Process of Replication

Initiation Phase
- Replication fork & bubble at origin of Replication
- DNA gyrase→open turn of DNA & form a ladder like body

Helicase→Break base bonds
SSB→Prevent pair up again of base
Single strand→act as a template
Replication fork his formed

Extension phase
- Done by polymerase enzyme
- RNA primase build primer (align nucletide act as start site of polymerase) polymerase III)
- Dimer need primer
- 5′→3′end
- Prof reading ability
- Both units are joined by polypeptide
- Leading strand→grow continuously toward fork
- Lagging strand away from fork
- Okazaki fragment are needed (100-200 base pairs in prokaryotes)
- Grow discontinuously
- More primers needed

> Polymerase I -termination & support DNA polymorease III
> Polymerase II- Reparing of DNA Damage in cell
> Polymerase III-main enzyme synthesize both daughter stand

Termination Phase
- Replacement of primer by DNA & Joining of okazaki fragment
- Polymerase I → Polymerase / Exonuclease
- Remove the primer & Replace it with DNA
- Attached to 3′ end of okazaki & 5′ end of primer
- DNA ligase: DNA Joining at okazaki fragments

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Chromosome & DNA

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Gene expression

Central dogma
Mechanism of gene expression
•mRNA formation & Translation

Transcription
Process of mRNA formation by help of RNA polymerase.

Initiation Phase
•Polymerase bind at promoter (regulatory Site) towards 5′ end
•prokaryote→ -10 TTATAAT
TTGACA → -35
•Eukaryote TATA (-25) CAAT (-70)
•Name due to position of polymerase at before initiation site
•RNA polymerase→beta, bete' sigma (Binding)
•Beta+beta' (Core enzyme)
•5'→3' No Primers needed
•Prokaryote → one types
•Eukaryote
I-rRNA
II-mRNA
III-tRNA
•DNA unwind & transcription bubble appear.

Elongation Phase
•Sigma factor released
•Core enzyme do elongation
•5′→3′
•Extend till terminator comes
•Template strand called antisense other is called as coding or sense strand

Termination stop mRNA synthesis
•GC base pair followed by AT pairs on DNA
•GC hair pin formed till AU comes
•Elongation stopped

Post-Transcriptional Modification of mRNA
•mRNA→mature needed in Eukaryotes because mRNA travel a long distance may be damaged by nucleus & phosphates
•Cap→7methyl GTP at 5′→5′
•Tail (poly A 30-500) 3′→3′ end
•RNA splicing entron (non coding area) are removed from mRNA called RNA splicing

Genetic code
Sequence of DNA/RNA that encode specific sequence of amino acid
•Coding / sense strand
•Also called codon
•A, G, C, T
•Codon specify mRNA & Amino Acid
•3 letters , 64 possible codons
AUG→Start
UAA, UGA, UAG→non sense codon
•Sense codon→encode
•Many AA are coded by more than 1 codon
•Leucine→6
•Pregnancy, Redundancy
•Universal

AGA → Arginine (bacteria)
UGA → Stop / Tryptophan (mitochondria)

Translation
•2nd stage of gene expression
•mRNA→protein sequence
•Bacteria→cytoplasm where ribosomal units are located
•Eukaryotes→Ribosome of RER

Process

Activation of AA
Biting of AA on tRNA & form Aminoacyl tRNA complex
•Catalyzed by aminoacyle tRNA synthase
•AA are continuously activated

Initiation complex
Ribosomal subunit+ mRNA+Aminoacyl tRNA
•tRNA→bind to smaller sub unit catalyzed by inrtion factor
•5′end of mRNA also bind to Ribosome by initiation factor.
•Completed when large subunit placed upon smaller subunit
•Psite→1st tRNA complex attach, peptide bond is formed between AA
•A site→tRNA attached
•E site→empty tRNA's leave Ribosome

Polypeptide elongation
Ribosomal unit move along mRNA, AA brought by tRNA are joined by polypeptide 3 step
•Anticodon of tRNA attach with codon of mRNA at A site by elongation factor.
•Peptidyle Transferase---P site join coming amino acid.
•Sub unit move along mRNA from 5′→3′ new codon exposed (translocation)
tRNA leave by E site (A→ P→ E)
•Process is repeated

Termination
•Elongation continue till non sense codon is exposed at A site.
•Stop codon→release factor that terminate the translocation & polypeptide is released from tRNA
•tRNA released from Ribosome &
•Ribosomal units are separated

Chromosome & DNA

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Regulation of gene expression

Importance
- Increase versatility & adaptability
- Drive cellular differentiations & morphogenisis
- Different cell type have different gene expression

Gene Regulation Methods
- Positive Regulation expression is increased by activator
- Negative regulation expression is diminished by repress.

Lac operon
- Positive Regulation obtain energy from β-glactosides (lactose)
- Genes are clustered on operon that regulate catabolism of substrate from outside (lac-operon) synthesis of AA (trp-operon)
- RNA→polycistronic→Multiple protein from single transcript

c = Repressor of operon
z = β-glactosidase (hydrolysis of lactose)
y = Permease (increase Permeability of cell)
a = transacetylase (transfer acetyl group) from Acetyl CoA→β-glactosidase)

Mutation

Introduction
- Permanent change in DNA
- Single Nucleotide→ Chromosome caused by radiation, viruses transposoms, mutagen & error in meiosis
- Agent called mutages & organism in which mutation occur called mutant
- Some mutation are rare, if occur in more then 1% of population called polymorphism
- Polymorphism→sometime risk the health

Origin of Mutations
- Heredity mutation inherited from parents, present in every cell.
- De-novo:- occur just after fertilization, effect every cell, but no family history
- Acquired/somatic:- occurs in lifetime, caused by environmental factors such as UV cannot be passed to new offspring.

Types of Mutation
Spontaneous-occur naturally & automatically by internal factors
- Induced mutation, by external mutations
- Point mutation: involve few bases
- Chromosomal mutation involve,change number of chromosome

Point Mutation
Deletion→Removal of Bases
Insertion→addition of Bases
Substituion→Replacement of Bases

Abberations

Deletion
Removal of segment of chromosome

Inversion
Part of chromosome Break & Join is different manner

Translocation
Shifting of chromosome on non Homologous

Duplication
Repetition of genes in chromosomes

Euploidy
(loss or addition of set of chromosome
Triploidy (3sets)
Tetraploidy (4sets)
Pentaploidy (5 sets)
Hexaploidy (6 sets)

Aneuploidy
(addition / loss of chromosome)
Monosomy (2n-1)
Nullisomy (2n-2)
Trisomy (2n+1)
Tetrasomy (2n+2)

Types of Mutagens

Physical
Short wave radiation
Discovered by H.T Muller
X-Ray, Gamma, UV
Cosmic rays
- Break chromosome
- Cause cancer
- Effect Replication

Chemical
- Mustard gas, formalin, nitrous acid 5-bromouracil, caffine, nicotine
- Ist discovered mustard gas used in 1st world war

Features	Sickle Cell Anemia (Drepanocytosis)	Phenylketonuria
Introduction	Sickle-cell anaemia is an ***autosomal recessive*** genetic blood disorder characterized abnormal, rigid, sickly shape red blood cells resulting in decreased flexibility. Hence RBCs get stuck more easily in small blood vessels, and break into pieces that interrupt healthy blood flow.	(PKU) is rare condition in which a baby is born without the ability to properly break down an amino acid called ***phenylalanine*** which is needed in body's production of melanin, the pigment responsible for skin and hair color. It is an ***autosomal recessive*** trait.
Signs and Symptoms	Signs and symptoms usually begin in early childhood. It includes a low number of red blood cells (anemia), repeated infections, and periodic episodes of pain, shortness of breath, fatigue, and delayed growth and development in children. The rapid breakdown of red blood causes ***jaundice.*** Painful episodes (called ***crises***), which can last from hours to days. These crises can affect the bones of the back, the long bones, and the chest.	Infants with the condition often have lighter skin, hair, and eyes than brothers and sisters without the disease. A "mousy" or "musty" odor may be detected on the breath and skin and in urine. The unusual odor is due to a buildup of phenylalanine substances in the body. Other symptoms may include: delayed mental and social skills, head size significantly below normal, hyperactivity, jerking movements of the arms or legs, mental retardation, skin rashes, tremors, and unusual positioning of hands.
Cause & Risk Factor	HbS which encode defective β globin chain is originated from HbA (normal haemoglobin gene) due to a point mutation. It results in abnormal haemoglobin. The patients inherit two such alleles from both parents. Carriers do not show signs and symptoms. Sickle cell disease is much more common in people of African and Mediterranean descent	An enzyme called phenylalanine hydroxylase, is missing which is needed to break down an essential amino acid called phenylalanine Without the enzyme, levels of phenylalanine and two closely-related substances build up in the body. These substances are harmful to the central nervous system and cause brain damage
Treatment	The goal of treatment is to manage and control symptoms, and to limit the number of crises. Folic acid supplements should be taken. Folic acid is needed to give regularly to prevent stroke, pain medicines, plenty of fluids. Other treatments of sickle cell anemia may include: hydroxyurea (Hydrea), a medicine that may help reduce the number of pain episodes (including chest pain and difficulty breathing) Antibiotics to present bacterial infections in child with sickle cell anemia	Treatment involves diet that is extremely low in phenylalanine, particularly when the child is growing. Phenylalanine occurs in significant amounts in milk, eggs, and other common foods. The artificial sweetener ***Nutra Sweet*** (aspartame) also contains phenylalanine. A special infant formula called ***Lofenalac*** can be used as a protein source that is extremely low in phenylalanine and balanced for the remaining essential amino acids

Features	Down's syndrome	Klinefilter's syndrome	Turner's syndrome
Introduction	It is characterized by the presence of an extra copy of 21st chromosome. So these individuals generally have 47 chromosomes (2n + 1).	Klinefilter's syndrome (also called XXY syndrome) is a condition in which human males have an extra X chromosome. Klinefelter syndrome does not occur in females	Turner's syndrome is chromosomal disorder which is characterize by the missing of one X chromosome (44 + X).
Sign and Symptoms	These include: A flattened face and nose, a short neck, a small sometimes with a large, protruding tongue, small ears, upward slanting eyes, small skin folds at the inner corner (epicanthic fold) and inner corner of the eyes may be rounded instead of pointed. White spots may be present on iris. The hands are short and broad with short fingers, and with a single crease in the palm. Poor muscle tone and loose ligaments are also common; and developmental milestones are not reached.	***As babies***, many XXY males have weak muscles and reduced strength. They may sit up, crawl, and walk later than other infants. Less testosterone production. This can lead to a taller, less muscular body, less facial and body hair, and broader hips than other body. ***As teens,*** XXY males may have larger breasts, weaker bones, and a lower energy level than other boys. They tend to quiet and shy. ***By adulthood,*** XXY males look similar to males although they are often taller. XXY males can have normal sex lives, with little or no sperm. Between 95 percent and 99 percent of XXY males are infertile. They feel trouble using language to express thoughts and needs, problems reading, and trouble processing what they hear	Short stature, Non-functioning ovaries, No estrogen and progesterone production so no menstruation or breasts development, have normal other genitalia so pregnancy with donor embryos may be possible. In early childhood, frequent middle ear infections. Recurrent infections can lead to hearing loss in some cases. Normal intelligence with good verbal skills and reading skills. Some have problems with mathematics, memory skills and fine-finger movements.
Causes & risk factor	Autosomal non-disjunction resulting gamete with 24 chromosomes. It's incidence 1 per 800 births before the age of 30, more common with older parents For example, a women has risk of Down syndrome up to about 1 in 350 by age 35. By 40 the risk rises to about 1 in 100	Non-disjunction of sex chromosome during oogenesis in mothers. These persons inherit two X chromosome from mother and a Y chromosome from father, so they have sex chromosome trisomy (XXY). It affects 1 in 500 to 1,000 males; most variants of Klinefelter syndrome are much rarer, occurring in 1 in 50,000 or fewer male births.	Sex chromosomal non-disjunction during oogenesis in resulting in nullo gamete production It occurs in about 1 in 2,500 female births worldwide, but is much more common among pregnancies that do not survive to term (miscarriages and stillbirths)
Treatment	No specific treatment available some measures include like: Corrective surgery for heart defects, gastrointestinal irregularities, regular health checkups to screen for other conditions such as visual impairments, ear infections, haring loss, hypothyroidism, obesity Individuals with Down syndrome should be fully included in family and community life	Testosterone replacement therapy (TRT to develop more masculine appearance and identity, deepen the voice, and grow facial and body hair. Educational service and physical speech and occupational thereby may also increase their confidence level	Treatments include: Growth hormone injections are beneficial to increase final adult height by a few inches. Estrogen & progesterone replacement therapy can help in breast development and start of menstruation which is necessary to keep the womb healthy, it also prevents osteoporosis

Evolution: Theory based on origin of life. (Special creation) (Biochemical evolution)

Theories

1)ARISTOTLE
- Scala Naturae
- Ladder of Nature
- Included all Organsims
- Thought to be permanent
- Non living matter → fungi → insects → animals → human beings

2)George Curies
- Catastrophism
- Large number of organisms originated
- Succesine catastrophes psoduced rock layers
- Destroyed species
- Fossils formed
- Hodern day flora and fauna

3)Louis Agassiz
New creation after each catastroph.
Modern species originated from recent ones.

4)Hutton and Charles
Uniformaitarianism
- Wind, water, earthquake, volcanes created layered patterns.
- Rocks are evidence
- Natural process

Charles Darwin
- Natural Selection.

Origin of eukaryotes from prokaryotes
15 → 2 billion years ago

1)Endosymbiosis: (Lynn Margulis)
2 separate beneficial invasions of prokaryotes produced modern day

Mitochondria	Chloroplast
• Small heterotophs • Capable of respiration • Become part of large cell by direct invasion or parasite	• Cyanobacteria • Second invasion • Indigestable food course

Similarities with prokaryotes
- ⇨ Binary fusion
- ⇨ Separate RNA and DNA
- ⇨ Independent of host cell's cycle
- ⇨ More similar to prokaryotes

2)Membane Infolding
- ⇨ Host cell membrane infolded to surround prokaryotic cells
- ⇨ Membrane removed intact
- ⇨ Protomitochondria
- ⇨ Proto chloroplast
- ⇨ Continued membrane infolding created endomembrane system
- ⇨ Eukaryotes involved from prokaryotic symbiotic multicellular interactions.

LAMARKISM
- Based on acquired characters
- Use and disuse of organs
- Structural change of organisms or deviations in lifetime results from change in environment or use or disuse of organ
- Bodily changes do not give rise to new species unless they are inherited
- Wrong interns of genetic principles
- Example:

⇨ **Pythons**
- ⇨ Loss of limbs due to crawling and concealing habits and change of habitat weasel alise

⇨ **Giraffe**
- Ancestors forced to live where grass was limited
- Started browsing upon trees
- Effort resulted in elongated forelimbs and necks.

DARWINISM
Origin of species by natural selection
- New species originate from natural forms by accumulation of adaptations
- Darwin Wallace theory: Salient features

a) Over production
- Organisms produce large No. of offsprings
- Limited resources (food, Space, nutrients)
- Limited offpsings survive due to competition

b) Struggle for existence

Intraspecific	Interspecific	Extraspecific
Members of same species	Prey or Predation	Struggle against natural focus

- ⇨ Aims at self preservation or self perpetuation
- ⇨ Competition for necessities of life

C) Variations
- No two individuals are like
- According to Darwin it is heritable

Harmful	Useful
• Handicaps the individual • Disadvantage	• Increases the chance of survival • Advantage

d) Natural selection
- Nature selects the most suitable
- Survival of the fittest ⇨ termed bu Herbert Spencer

f) Speciation
- Survived species transfer their traits to offsprings
- Descendants different from ancestors
- Formation of modified /new species

Neodarwanism

New theory, involves genetic mutation, drift and gene flow.

Features	Description
Genetic Recombination	●Random Assortment of gene due to meiosis ●Crossing over ●New characters and variations
Chromosomal and genetic mutation	●Mutation leads to useful or harmful characters ●Changes in DNA sequence brings about variations
Natural selection	●Environment modifies species to fit in it ●Uses variations and mutations as raw materials for evolution
Reproductive Isolation	●Most important ●Restricts interbreeding among individuals of different species
Genetic Drift	●Concerned with changes in gene frequencies ●When species expend or migrate they become genetically different ●Frequencies fluctuate until mutations are lost or fixed ●New species modified according to new habitat and resources ●Determines evolutions

EVIDENCE OF EVOLUTION

Evidence	Explanation	Examples
Comparative Anatomy	**Homology:** Phenomenon of structures having similar arrangements of parts but different functions. **Divergent Evolution** **Analogy:** Phenomena of structures having similar function but different origin **Convergent Evolution**	● Human hand, bat wings, horse's leg have same bones, muscles, nerves and mode of development but different functions ● Wings of birds, butterflies and flying lizards have same functions.
Fossils	● Remains of ancestral species ● Provide long ancestral line of evidence of species	● Archeoptesyx have both bird and reptile like characters ● Modern day Giraffes have longer links and neck ● Ancestral horse cophippus is different from modern Equs
Vestigial Organs	● Organs become reduces or loses their function with time	● Apendix, coccyx bone, mammary glands in male ● Hind limbs in pythons and sharks.
Bio Chemistry	● All organisms exhibit similarity in biochemistry ● Same composition in protoplasm	● Struction and function of DNA and RNA is same ● Process of protein synthesis ● ATP as a reservior
Molecular Biology	● Biochemical similarity ● Same method of trapping and transferring energy	● Universal Genetic Code ● DNA and RNA for inheritance of traits in all organisms
Embryology	**Karl Von Baer:** ● Adult vertebrates may differ in and habits but have same embryos ● All organisms began their life as unicellular fertilized egg	● Cleavage of blastula, Gastrula is same for all ● In development of frog there is a fich like stage

Evolution

Von Baer and Hackle:

Ontogeny recapitulates phylogeny
In development each individual tends to climb to its own family tree.

- Zygote → unicellular ancestor
- Glastrula → diploblastic ancestor

Divergent Evolution

- Process of 2 or more related species becoming dissimilar
- Similarity is due to shared developmental path ways
- Organisms had diverged from common ancestors
- Early developmental stages have changed less than later

Kit for
Lives on plains, in deserts
Ears are large for evaporation through large surface area
Sandy colour for cealing for prey

Red Fox
Lives in mixed farmlands
Red color helps it blend in with trees

Hardy Weinberg Theorem

In large randomly breeding population allelic frequencies remains same in generation if following conditions remains same:

- Mutation
- Natural selection
- Large population
- All members breed
- No migration
- Mating is random
- Everyone produces same number of offsprings
- **Equation: $P^2 + 2pq + q^2 = 1$**

Convergent Evolution

- Process in which organisms not related, independently evolve similar traits due to similar adaptations
- Unrelated species become more and more similar
- **Cactus**
- Grows in American deserts
- **Euphorbia**
- Grows in African deserts
- Both have fleshy stems armed with spines for storing water and protection against predators

Speciation

Evolutionary process by which new species form
There are 3 steps bellow:
1) Isolation of population
2) Mating system to diverge
3) Reproductive isolation

Conditions

Polyploidy, Variation, divergence, genetic drift and natural selection.

Sympatric speciation

Most rare form

- Occurs when populations isolate
- Most common in polyploidy, tetraploid cannot mate with diploid creating reproductive isolation
- Common in plants, due to self fertilization
- A polyploid organism must find same species in opposite sex with same polyploid condition to mate

Allopatric Speciation

Most Common

- Occurs when species become geographically isolated
- Must go through founder effect
- In separated populations gene flow ceases
- Selection and genetic drift will out
- Result is difference in genetics of new species

Parapatric Speciation

Extremely rare

- Occurs when species are separated b extreme habitats
- Develop distinct characters and lifestyles
- Reproductive isolation is behavioral

Example:

Plants living on boundaries flowers at different times due to extreme environments.

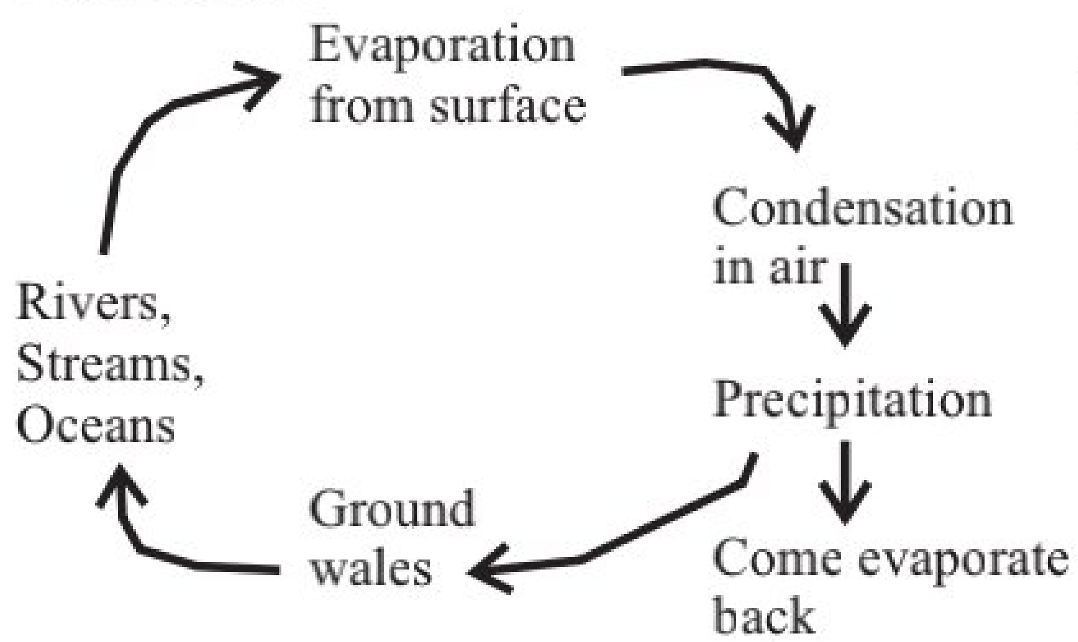
Environment: Physical, chemical, biological surrounding of an organism. Maintaining it is conservation.

↓

Biogeochemical Cycles: Flow of elements between organisms. Out of 92, 6 are essential elements.

Water Cycle:

97% salt water
3% is fresh
2% is solid
1% drinkable



Biological Fixation:

Rhizobium → symbiotic association with leguminous plants.

1) Infection threat is made in response by root cell
2) Thread penetrates, root cells proliferate
3) Nodule form in a week.

Anabaena Azollae is cyanobacterium

- Nitrogen fixation involves N_2 conversion to nitrogenase complex, that is sensitive oxygen.

Aerobic bacteria (Azotobaceter) adaptations:

- High metabolic rate
- Physical barrier
- High respiration rate
- Low O_2 in cell

Nitrogen Cycle

- Required for proteins
- 80% N2 in atmosphere

(a) Fixation

Industrial
- Habour's Process

Biological
- 60% N_2 Fixed by Bacteria

Lightening
- 5-8%
- Thunder
- Atmospheric Changes

↓

- N_2 Reduced to NH_3
- 16 ATP and enzymes required

(b) NITRIFICATION

Ammonium → Nitrites → Nitrates

1) Nitrosemonas

$NH_4 \xrightarrow{\;\;2\;\;} NO_2$

2) Nitrobacter

$NO_2 \longrightarrow NO_3$

- Neutral pH and aerated soil

(c) DENITRIFICATION

Psuedomoras

$NO_3 \rightarrow N_2 + NO_2$

- Nitrogen removal from soil
- Less fertile for plants
- Anaerobic medium required

(d) AMMONIFICATION

- Decomposers convert organic N_2 → inorganic N_2
- Organic matter is consumed
- Ammonium ions → Nitrates by nitrification

Energy Transfer: 10% transferred b/w levels

1st tropic level
- Primary producers (Plants, algae,bacteria)

2nd Herbivores

3rd Predators

4th Tertiary
- Decomposers

GPP: Total organic matter produced

NPP: Remaining energy after subtracting the faction used by the producer.

- Factors affecting productivity
- Temperature, moisture, light
- In oceans it is proportional to light
- Productivity less in desserts
- On land, vascular plants carry out production
- In oceans algae is producer.

Eltonian pyramids

Biomass: Amount of energy in biomass, in g/m^2 or cal/m^2

- Demonstrates amount of matter lost dunring trophic levels. Each level depends on lower level.

Numbers: Varies with ecosystem shows member of organisms

Energy: Amount of energy lost.

- Always upright
- Energy is lost while going up the level
- Energy is lost as heat as well

KIPS PREPARATIONS

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Succession: Directional, non-seasonal cumulative change in plant species occupying an area.

- **Primary:** Colorization and establishment of pionear species.
- **Secondary:** Invasion of habitat on a previously cultivated land, that has been destroyed before.

Xerarch

- On bare grounds on rocks

Hydraich

- On shadow water, ponds etc

Xerosere: Succession on extremely day land, lithoseres on rocks etc.

1) **Lichen Stage:** Poineers, adhere to rocks.

- Releases acids to corrode rocks → soil
- Dead lichens thallus forms humus
- Absorbs moisture
- Suitable soil for growth of foliose and fruiticose.

2) **Foliose & Fruiticose stage:** Foliose → leavethalli → fructose → bushes.

- For moisture absorption and accumulate dust.
- Dead remains → humus → substratum.
- Parmelia & dermatocarpon community.

3) **Moss stage:** Spores invade rocks, rhizoids penetrate soil and secrete acid to corrode rock.
Moss bodies rich in organic & inorganic matter.
Increase fertility can also catch soil from air.

4) **Herb stage:** Asters and primroses invade rocks.

- Acid secretion---------promotes weathering.
- Leaf litter and death herb adds humus.
- Shading of soil------------decrease in evaporation.
- Temperature rises, biennial and pereninals herbs and xeric grass begins to inhabit.
- Climate promotes decomposition activity of bacteria and fungi.

Shrub Stage: Grass and herbs are invaded by shrubs.

- Slow process
- Dense growth of shrubs leads to death of herbs.

Tree Stage: Climate favours colonization.

- Kind of tree inhabiting the land depends on soil.
- Shade lowing shrubs grow as secondary vegetation.

Forest Stage: Climax stage

- Forests type depends on climate

Carrying Capacity:

- K
- Maximum stable population size an environment can hold
- Population size declines as it reaches carrying capacity.

Fossil fuel	Nuclear Power
Provide energy by releasing greater house gases.	Provide energy by burning of nuclear substances.
Larger waste material	Less waste material
Waste non-radio active	Waste is radioactive
Expensive	Cheaper

Population Dynamics: Life science deals with number, age & composition.

Population size: In degree of reproductive isolation it is gene pool.

- In geographical range means number.

Population Density: Number of organisms per unit area per unit mass.

Population Distribution: Distribution over a geographical range.

a) **Clumping**

- Attraction
- Unequal distribution

b) **Uniform**

- Same distance
- Repulsion

c) Random

- Interaction/ Influence
- Unequal range

Population growth:
No limitation in environment
Increase in numbers

Intrinsic Rate
Ideal conditions
Fast growth

Exponential Rate
Size at a given time equal size at an earlier time.
With in limits.

Carrying capacity

Maximum stable population that a particular environment support. (K)

- As K reach resource are reduced or high death rate. Growth limit to zero

Problem of rapid population growth

•Population growth σ use of soil water energy •Who ⟶1-2 billion people malnounshed (low income less food) •80m-China alone after •50 years-population 12 billion •99% food from land •1%from ocean•Soil is degraded. •1/3 land (1.5 B hecter) is abandoned by soil erosion) •500year-25mm soil formula • 8m liter water/hectase. •87% freshwater is not recoverable. •water borne disease (6m death/year). •Conservation should be done efficient technology should be used.

Pakistan population planning

- 1950-Mortaty rate 27/1000
- 1990-12/1000 •6.2 child-family
- 11% couple-coatraception
- 1950-NGO-population growth control.
- 1960-IVD were promoted
- program suspended in 1969
- 1971-652m population
- 1980-population welfare
- Division-ministry of planning & economic division

Human impact on environment

Man ⟶ damage all resources of env. In 19th century population was less but now we are facing depletion & pollution, deforestation as

- Urbanization, polluted soil, water, air
- Degradation & depletion

Need of Nuclear Power

Fossil fuel ⟶ pollution, depletion, green house gases.

Nuclear Power: Clean, cheaper, no residue, no pollution, energy of atom, no CO_2 in air.

Draw Backs: Waste disposal & env issue

1) safety, radiative accident, waste disposal.

2) **Reactor accident:** Chernobyl-100M curie leakage & three mile island 15 curie leakage ⟶ damage public confidence environment.

3) **Waste disposal:** Waste ⟶ swimming pool ⟶ geological formation.

4) **Weapon Proliferation:** U235 (>90%) ⟶ bomb plutonium can also be used for bomb.Breeder reactor can use plutonium 239. Chernobyl (1986) ⟶ due to Hawed reactor design ⟶ 5% core env 2 death on spot 28 died after weeks. ARS ⟶ 237 person. 19 died b/w 1987-2004 chernobyl is reactor destroy & 30 operator killed.

Env. Resources & depletion

Renewable

Fuel, gas
Rocks
Not recoverable

Non renewable

Replaced in short time
e.g. water 3% usable form

Depletion

Erosion, irrigation, overuse, unequal distribution, slash & burn.
Mining, agufer depletion, forestry
Pollution, development

Non conventional sources

1) **Tidal power**

Tidal energy ⟶ usable form tide ⟶ by sun & moon gravity, spring tide, neap tide. 705 tide/year.

Wind Power

Less cost wind ⟶soil ships uncertanity of wind, wind farm, wind mill

3) **Geothermal**

1 C increase-35-40meter deptgh
3-4 km-water boil
15km-1000-2000 °C
water ⟶ steam ⟶ gyser
Hot spring, moltan lava have water, which can also be used.

4) **Mhd**

direct heat ⟶ electricity
More efficient

Conventional method

Heat ⟶ steam ⟶ turbine ⟶ energy
Loss output energy (37-40%)

5) **Solar Power**

1.6×10^{18} unit of energy come on larth
2000 times greater

- Cause evaporation
- Heating of building
- Solar energy ⟶ electrical
- Chemical conversion

Conventional Source

Available all time
Pollution, GHG acid rain, expensive
More cost ro env
Not grow quick

Sources of CO_2
Fossil fuel combustion oil & gas burning. Industry.
Electricity Generation
41% of all emmision
Industry
Mining, construction refining, food, Paper, metal production
Residental
Heating, lighting burning of gas.
Transportation
2nd largest source
Jet fuel, diesel, gasoline, aircraft, trucks, trains, boats
Deforestation
Removal of forest
Global sequestrations
CO_2 → underground reservior oil & gas plants

Global Warming
Warming of earth temp due to GHG (Trap Heat)
- CO_2 act as green house
- Allow entry of sunlight but restrict escape
- GHG → CO_2, N_2O, CH_4, H_2O
- 1.5-4.5°C rise of temp at the end of next century.
- Polar ice cap melt
- Coastel flooding
- Threatened ecosystem effect rainfall ocean current
- Distribution of trees
- Effect breeding of species.

Acid Rain
Water in air React with SOX, NOX
- pH less than 5.6
- Effect fertility, acidity & vegetation
- Kill aquatic life
- Stone cancer
- Common in USA, Canada,
- Europe, Sweden, Norway,
- Germany

Ozone Layer
30-50km is stratosphere (90% of all)
12000/1000, 000, 000 air
- Filter UV rays. Protect earth pollution liquidator reduce pollution by forming new compounds
- UV → O+O → O_2+O → O3
- Balanced by this reaction
- May migrate to troposphere
- DV 100 DV=1mm of ozone

UV Radiation & Human
Skin → form vitamin D & protect from UV.
Near equator → more dark skin & vice versa
dark skin → less chance of cancer
- UV → skin burn, photoaging skin cancer • 10% decrease in ozone → 30000 non-melanoma & 4500 melanoma. UVB → damage immune cells UV → by eyes → body → cataract, blindness 16M people → blindness, WHO → 20% due to VU light
- UV damage → depend on skin type.

Biology & Human Welfare

Integrated Disease Management

- Effective control of disease
- Awareness
- Prevention
- Vaccination
- Treatment
- Combating with combined effort

Vaccination

- Name by: Louis Pasture (vacca) vaccine
- Discovered by: Edward Jenner
- Small pox vaccine from cow pox liquid
- Stimulation of immune system
- Development of artificial Vaccine

Vaccine Properties

- Can be live but weak
- Dead Pathogen
- Attenuated component of pathogen
- Can be toxoid

Vaccine Principle: Injected
↓
Stimulation of natural active immunity (No Discase)
↓
Killing of weak pathogen and memory cells produced
↓
Long lasting immunity for later life

Types of Vaccines

Types	Advantages	Disadvantages
Live attenuated vaccine	Closest to natural infection contains weakened microbes strong cellular antibody response. Life long immunity with only one dose.	Changes due to mutation. Can get back virulent germ.
Inactivated or killed vaccine	Chemicals, heat, radiation, killed. More stable. Easy to transport, store. No refrigeration.	Weaker immune response. Requires multiple doses.
Subunit vaccine	Includes epitopes so antibodies can recognize. Contains only essential parts that cause disease.	No adverse reaction to vaccine
Toxoid	Effective against pathogens that secretes toxins. Can be inactivated by treating with formalin detoxified and sterilized	———

Animal Husbandry

- Deals with study of various breeds of domesticated animals and management for better products.
- 30-35million people involved in Pakistan.

Wild Animals
- breed better when free
- No use for humans
- Lions, Tigers, deers etc

Tamed Animals
- Trained to be useful to humans
- Elephants, Yak, Gorillas

Domesticated Animals
- of use at home
- Easily breeded
- Dog, Sheep, Buffalo

- Importance of domesticated animals:

<u>Milk yielding:</u> Cattles, Goats
<u>Draught:</u> Loading & carrying
<u>Fibre, Skin:</u> Camel, Cattle, Sheep
<u>Meat and egg:</u> Hen, Duck, Goat, Buffalo

Disease	Vaccine	Types
Polio	(OPV) Oral Polio Vaccine	Live
TB	Bacillus Calmette Guerine (BCG)	Live
Typhoid	Typhoid Vaccine (TAB)	Killed
Hepatitis	Hepatitis B Vaccine	Subunit
Diphtheria Tetanus	Diphtheria toxoid + Tetanus Toxoid Vaccine	Toxoid

Types of Animal Husbandry

Milk & meat yielding	Draught Animals	Fibre & skin yielding	Egg yielding
Cattles, goats & cows are used. Females contribute to milk. Males contribute in agricultural economy by providing labour. Milk can be transformed into different dairy products. Depends upon fat content. Cattle dung is used to make dung cakes for fuel. Biogas is obtained. Manure used as fertilizes for crops.	For carrying loads. Riding ploughing etc. Includes donkeys, mules, camels etc.	Provides useful products. fibre, skin, hide. sheeps provides fibre for woolen strings, ropes, carpets, clothing, brushes, shoes etc.	Eggs are used as a protein source. Poultry farming includes rearing of birds such as hens, ducks. It is easily manageable and with quick results.

Genetic Improvement in animals

- To increase milk, egg, meat productivity.

Artificial Insemination

- Collection of semen from desired bull.
- Storage at low temperature.
- Introduction in other female.
- Up to 3000 females can be fertilized from semen of one bull.
- Easy storage and transport.
- High success rates.

Embryo transplant

- Embryos from superior breeds.
- Transferred to females with inferior characters.
- Common in goats and sheep.
- Quality and production improved.
- Chances of contamination.
- Less success rate.

Techniques for plants

- Increase in quality.
- Resistance to pests.
- Increase in tolerance.

Acclimatization

- Adjusting an organism to gradual changes in environment so to increase tolerance.
- In vivo process.
- Organisms changes cells biochemistry by making them more fluid in cold & less fluid in warm temperature.
- Heat shock proteins acts against stress.
- Several plants such as tomato, maple trees are acclimatized slowly and gradually.

Selective breeding

- Change in genetics of plants to obtain desired characters.
- Use of DNA finger prints and molecular markers.
- Screening is based on presence and absence of genes.
- Allows higher yield, resistance and adaptation in plants.

Hybridization

- Interbreeding of related or distant species to produce variations.
- Mildew resistant pea is crossed with high yielding pea so to maintain both traits.
- Backcrossing and interbreeding is to maintain progeny.
- Such plants are self crossed to maintain the variation.

Genetic Engineering in Crop Improvement

- Desired gene can be inserted in genome by bacteria (agrobacterium tumeficians) & gene gun.
- Bacillus thuringiesnsis is a soil dwelling bacterium alternative to pesticide.
- Herbicide binds to plant enzyme and inhibit action.
- Enzyme are called herbicides target site.
- Herbicide resistance is done by expressing a version of target site.
- Protein, not inhibited by herbicide.
- Used to produce glyhosate resistant crop plants.

Role of microbes in human welfare

- Microbes can be beneficial & harmful.
- Responsible for various ecocycles.

Food processing

- Influence quantity & quality & change in different substances.

Yoghurt making

- By bacterial fermentation of milk.
- Lactose is fermented into lactic acid by streptococcus salivarius and other bacteria.
- Collectively called (LAB) lactic acid bacteria.
- Acid curdles milk protein casein into curd.
- Gel like texture & taste is due to lactic acid.
- Acidity prevents proliferation.

Cheese making

- Solid part of curdled milk is curd & liquid is whey.
- Curd can be separated & pressed into desired shape.
- Flavor can be changed by addition of bacteria or fungus.

Alcohol industry

- Anaerobic respiration of yeast converts sugar to ethanol & carbon-dioxide.

Beer ⟶ maltose sugar.

Wine ⟶ grape sugar.

Malting

Beer is brewed from barely grain ⟶ germination ⟶ convert starch into maltose.

- Gibberellins & amylase speeds up germination
- Sugar extracted by crushing grain & boiling to produce wort.
- Wort fermented by yeast to make alcohol.

Pharmaceutical industry

Biopharmaceuticals

- Microbes are source of monoclonal antibodies, penicillin, insulin, antibiotics
- Bacteria are grow in large bioreactors.
- Insulin produced in unlimited quantities.

Antibiotics

Penicillin

- Secondary metabolite of fungus.
- Produced when growth of fungus is inhibited

Cyclosporine

- Immunosuppressant by Trycoderma polysporum

Lovastatin

- Blood cholesterol lowering agent.
- By monascus purpureus

Waste Treatment

- Sewage treatment to remove contamination.
- Objective is to produce environmentally safe fluid.
- Giant microbial culture breeding facility where microbes work.

Energy Generation

- Biomass is used to generate energy with microbial activity.
- Biomass utilization includes global carbon cycle of biosphere.
- Biomass energy develops from fuel wood, animal waste and agriculture residue.

Biogas: 50-75% methane and carbon dioxide with traces of nitrogen and other gases. Methanobacterium and methanogens are main source.

From Activated Sludge

- Includes solid waste from setting tanks.
- Methane produced is called biogas.
- Sludge removed from vats and effluent water as well.
- Vat sealed with methanogens to build pressure and gas.
- Solid waste is dryed and sold as fertilized.
- Methane gas produced is used as fuel.

From Cattle Dung

- Cattle dung produces gobar gas.
- Biowaste and dung which in bacteria are added in biogas tank.
- Gas is collected.
- Slurry used as fertilizer.
- Other waste and crops can also be used.

Uses

- Methane as fuel.
- Engines.
- Used to generate electricity on a lower sale.
- As power supply for treatment plants.
- Eco friendly environment.